THE

Sportſman's Directory:

OR,

TRACTATE

ON

GUNPOWDER AND FIRE-ARMS.

Entered at Stationers Hall.

Fig. 1. *Page 71.*

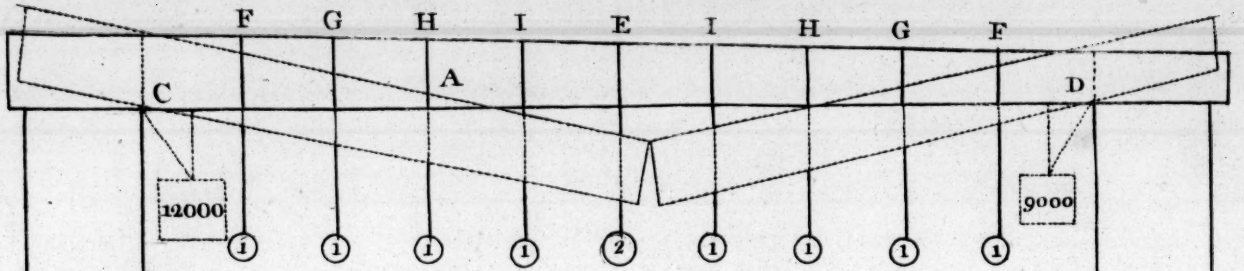
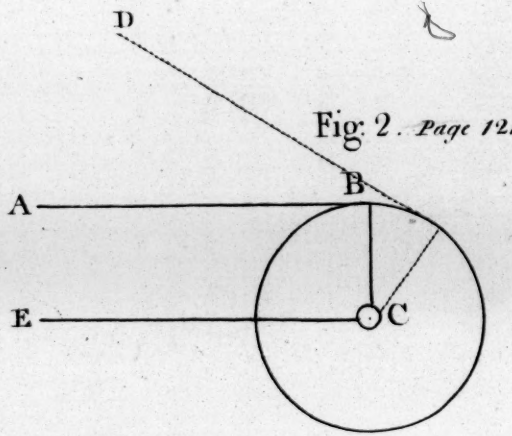


Fig. 2. *Page 121.*



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THE

Sportſman's Directory:

OR,

TRACTATE ON GUNPOWDER,

FOUNDED ON A SERIES OF EXPERIMENTS:

Together with

SOME REMARKS AND SUGGESTIONS

ON

FIRE-ARMS.

CONTAINING,

I. The advantage of ſmall-grained powder.

II. The moſt ſimple and perfect method of proving its ſtrength.

III. The unneceſſary expenditure of Government powder.

IV. Advantages of a Marine corps of Artillery.

V. Cannon and carronades formed contrary to mechanical principles.

VI. The principle on which guns burſt.

VII. Muſkets extremely defective.

VIII. The principle of rifle barrels miſtaken.

IX. Choice of guns for the ſportſman, with many uſeful inſtructions on the art of ſhooting flying.

X. On Piſtols—Outlines of Duelling.

TO WHICH IS ADDED,

A TABLE of GUN BARRELS, for the Uſe of Sportſmen, with their proper Charges and Killing Diſtances.

BY GEORGE MONTAGU, Esq.

LONDON:

PRINTED FOR R. FAULDER, IN NEW BOND STREET.

M.DCC.XCII.

TO THE

RIGHT HONOURABLE

LORD PORCHESTER.

MY LORD,

ALTHOUGH it may be preſumed, that there are ſome parts of this ſmall work which may not directly attract your notice as a ſtudy, yet a portion of no ſmall importance to the nation, founded on the baſis of experimental Philoſophy, may more immediately claim your peruſal, attention, and patronage as a Patriot, and, through your influence, on ſome future day be the origin of national benefit.

Your Lordſhip may recollect our converſation on the preſent ſyſtem of Gunpowder, concerning which you did me

the honour to aſk ſome queſtions two years ago, and which I have here endeavoured to refute, having ſpared neither pains nor labour to prove to you and the world the foundation of my aſſertions.

From great experience, I flatter myſelf I have reduced the practice of ſmall fire-arms to a conſiderable nicety; not forgetting to blend amuſement with utility, by pointing out the advantages of guns of particular conſtructions, with other requiſites neceſſary to become an adept in the field of ſport. Should you thereby be induced to put my maxims into practice, I ſhall at leaſt have one ſatisfaction, that of being conducive to your Lordſhip's health by exerciſe, ſo neceſſary to the animal œconomy.

From a mind ſtored like your's, ſhould a ſingle ray of approbation ſhine forth from the brilliancy of your judgment, it will buoy me up againſt the ſtream of

 prejudice

prejudice and diſſention, bounded only by theoretical propoſitions.

Permit me therefore to inſcribe and ſubmit this tribute to your friendſhip, as a mark of that reſpect and regard with which,

MY LORD,

I have the honour to be,

Your Lordſhip's moſt faithful

and obedient humble ſervant,

G. M.

CON-

CONTENTS.

Powder,

Their

ERRATA.

Page 3. line 5. from the bottom, *for* its *read* their.
—— 4. — 3. from the bottom, *for* in *read* by.
—— 47. — 15. *for* is *read* are.
—— 64. — 3. *for* they *read* it.
—— 70. — 4. from the bottom, *& alibi*, *for* branchiæ *read* brachia.
—— 76. — 25. *for* air againſt *read* air, againſt.
—— 83. — 11. *for* a muſket *read* muſkets.
—— 107. — ult. *for* exactly the ſame charge as, *read* rather more charge than.
—— 112. — 12. *for* Parrick *read* Patrick.
—— 115. — *in the table, under the column of Length in diameters, for* 68 *read* 68 $\frac{1}{4}$.
In the ſame table, under Diameter of the bore, for Fifths, *read* Tenths.

THE

SPORTSMAN'S DIRECTORY.

INTRODUCTION.

TO preface a ſmall work of this kind, which was written by the deſire of a few friends, only for their inſtruction and amuſement, would be ridiculous; nor would it ever have made a public appearance but by their particular requeſt. The original intent of the following experiments was to obliterate groundleſs ſuppoſitions, founded on theoretical errors; and to aſſiſt the ſportſman with the choice of his gun, and all its appendages, requiſite for the field of diverſion. Many of the experiments the author believes are original, and many uſeful concluſions and ſuggeſtions have been the reſult in his own mind, however they may ſtrike other perſons, who pretend to the knowledge. Scientific men ſhould recollect, experimental philoſophy is the groundwork of reaſon: let thoſe, who ſuſpect they have more knowledge in theory, put ſuch ideas into practice, before they attempt to aſſert what experiment will refute.

Founded only on experiments, the following ſheets were deduced; and, as many of thoſe experiments appeared big with information, and convinced the author of the immenſe unneceſſary expenditure of government powder, it led him ſomewhat from his original intention, and he extended his views to a national concern, thus blending uſeful ſcience with the pleaſurable accompliſhments of the ſportſman. Should he be the means of expanding the field of the artilleriſt, and that of the lovers of the trigger, and of a great ſaving to his country, he ſhould not think his time ill ſpent in copying his notes for the preſs. If it ſhould be deemed to poſſeſs the ſmalleſt portion of merit, or throw the leaſt ſpark of light upon the uſe of fire arms or gunpowder, it will render him ample ſatisfaction, and produce emulation to further inveſtigation of the ſubject. Let the judicious reader therefore peruſe it with candour and impartiality.

Whatever has been ſaid in order to diſcover the origin of defects in any of the particular branches under government, is not perſonally intended to attack individuals; neither is the refutation of any author's ſyſtem introduced, but to lead to the true diſcovery of the point diſcuſſed.

The cap of liberty is the only one the author is capable of forming: thoſe who wiſh to wear it have moſt certainly the liberty of doing it.

GENERAL

GENERAL REMARKS.

AS perſons are too apt to fancy they have the moſt unparalleled gun, the beſt method of loading, and the moſt unerring powder prover, it may not be amiſs to paſs a few general remarks on that head. In the firſt place, the difference in the velocity, in barrels of different lengths, is of very little importance to the ſportſman, in the uſe of ſmall ſhot. That a long gun requires a greater proportion of powder than a ſhort one is evident, becauſe the friction of the charge of ſhot is greater; conſequently a barrel of conſiderable length requires a proportional weight to produce the ſame proportion in the ſhot's velocity. Thoſe who expect to kill with ſmall ſhot, at a greater diſtance, with a long barrel than a ſhort one, are not to conclude it is from the additional velocity alone, but from the ſhot's forming a leſs angle from the muzzle at any given diſtance.

When we ſpeak of the length of a gun, it is not from the general terms of feet and inches, but from the meaſure of the diameter of the caliber or bore; the particulars of which, as well as of bullet guns, will be found in its proper place.

In reſpect to the charge of a gun, and manner of loading, moſt perſons are as whimſical as various; each concludes he has hit upon the beſt method, without being capable of reaſoning upon

the ſubject. But in this much depends, particularly in reſpect to the proportion of the powder and ſhot, according to the quality of the powder, the ſubſtance uſed by way of wadding, and the force required in ramming the charge: all of which will be made perfectly clear, by the numerous experiments on thoſe articles, and the obſervations thereon.

The laſt general remark I ſhall make is, that the common powder provers, as they are erroneouſly called, which are to be had at moſt gunſmiths ſhops, are mere toys, fit only for children's playthings, founded on no one principle for the purpoſe intended, and ſerve only to deceive noninventive faculties, and lead them into a labyrinth of errors: firſt, becauſe it is not the meaſure of powder that demonſtrates its real ſtrength, but its weight; and ſecondly, that the ſize of the grains are as neceſſary to be conſidered as the weight, becauſe the ſmaller it is granulated, the leſs ſpace it will occupy: it is therefore to be obſerved, that the greater quantity of powder in weight, occupying a given ſpace, the more elaſtic fluid will be generated in that ſpace at the moment of exploſion, augmented by the additional quantity of heat and rarefaction: for the force of fired powder is not occaſioned by the denſity of the elaſtic fluid alone, but in the compound ratio of the denſity of the generated fluid, and the degree of heat at the moment it is exploded.

I SHALL

I SHALL now proceed to the experiments on the force of gunpowder, with the deſcription of the different engines uſed for the proof thereof, together with remarks and obſervations on each reſpective experiment.

As I was totally unacquainted with any mode of proving powder, but what was either full of errors, or too complicated for general uſe *; and being well aſſured there is no way more perfect than that of throwing a weight by its force: I procured ſeveral ſmall mortars, of different ſizes and conſtructions. The firſt I tried was three inches diameter in the bore; the length of the chaſe one and a half of the diameter: the chamber contained an ounce and a half of ſingle Battel powder, ſuch as is generally uſed for fowling: its diameter one inch; its ſhape cylindrical. The mortar was elevated at an angle of forty-five degrees, and loaded with a quarter of an ounce of powder each time.

EXPERIMENT I.

Diſtance of the Shell's Flight meaſured in

	YARDS.
Double Battel powder - - - - - -	16
Single Battel ditto - - - - - - -	10

* See Mr. Thompſon on gunpowder, *Phil. Tranſ.* vol. lxxi.

Ordnance powder, as iſſued to the army in ball cartridges - - - - - - - - - 13
Ordnance ditto, the fine grains only of ditto - - - - - - - - - - - - - 23
Ordnance ditto, as delivered in barrel for exerciſe, fine grains - - - - - - 21

From this experiment ſeveral things are to be deduced: firſt, that powder in ſmall grains is ſtronger than when the grains are large; ſecondly, that government powder differs very conſiderably in ſtrength; and thirdly, that the ordnance powder, when reduced to the ſame ſize, exceeds this double Battel * in ſtrength.

It ſhould be noticed, that much caution is to be obſerved in experiments of this nature; for the difference of ſituation of a ſmall quantity of powder in the chamber of a mortar, will alter its force, as well as the ſmalleſt variation in preſſure uſed in loading.

Being rather aſtoniſhed at the ſuperiority of the ſtrength of military powder, I determined to repeat the trial again, but to vary the manner; and as, in the laſt experiment, the ball cartridge powder, as delivered from the ordnance ſtores, appeared to be ſtronger than the ſingle Battel, I proceeded to try thoſe two only in the following manner, with the ſame mortar as before, but with an angle of fifty-five degrees of elevation.

* The maker's name was forgot to be noted.

The

The quantity of powder was ſeventy grains in weight.

Experiment II.

The diſtance meaſured in - - -	FEET.
Government ball cartridge powder, whole grains - - - - - - - - - - -	30
Single Battel ditto, whole grains - - -	28
Government ditto, reduced partly to duſt by bruiſing - - - - - - - - -	51
Single Battel ditto, reduced ditto - -	66

From this experiment we are not wholly to conclude, that ſingle Battel powder, reduced partly to duſt, is ſtronger than the ball cartridge powder in the ſame ſtate; which would be the reverſe of reaſon from the firſt experiment: but, on the contrary, had the whole grains remaining in the cartridge powder been only of the ſame ſize of the Battel powder in grains, it would moſt certainly have thrown the ſhell fartheſt, provided alſo the pulveriſed part of each had been equal: therefore, it only ſerves to confirm, that gunpowder is ſtrongeſt in ſmall grains; and that even a quantity of powder duſt may be added with ſurpriſing advantage.

Being ſatisfied by repeated trials, that ſmall grains have ſuperior force to large, yet I thought the real proportionate ſtrength might not be diſ-

covered in this mode of trial, where there was a conſiderable vacant ſpace between the force and the body to be removed; or, in other words, between the powder and the ſhell; I made the following experiment with a very ſmall mortar, whoſe breech was moveable ſo as to enlarge or contract the chamber to any degree required; the conſtruction of it was ſuch, that the ſame weight of the largeſt or ſmalleſt grained powder might be brought in contact with the ball or weight to be moved.

The diameter of the bore was an inch and a half; length of the bore one diameter and a half; the diameter of the chamber one-fourth the diameter of the bore.

The powders uſed were the ſame as in the firſt experiment: the quantity fifteen grains weight: and the angle of elevation fifty-five degrees.

Experiment III.

Diſtance of the ball thrown meaſured in	FEET.
Double Battel powder - - - - - -	43
Single Battel ditto - - - - - - - -	25
Ball cartridge ditto, large grains, as in experiment 1ſt - - - - - - - -	28
Ball cartridge ditto, fine grains, ditto - -	54
Ordnance exerciſe powder, large grains, ditto - - - - - - - - - - -	22
Ordnance exerciſe ditto, ſmall grains, ditto	43

This

This ſtill continues to prove the ſuperiority of powder in ſmall grains, and anſwers perfectly with the firſt experiment, as near as can be expected with ſo ſubtle an elaſtic fluid, which is ſo frequently varied by very trifling and unforeſeen cauſes, eſpecially on ſo ſmall a ſcale: yet upon the whole, this is the moſt perfect, ſimple, and portable powder prover I have hitherto diſcovered. It may not be improper here to point out more particularly the fallacy, and animadvert on the common powder provers; by which the advantages of the one above ſpecified will be more clearly underſtood.

Theſe are conſtructed in ſuch a manner, that, were they loaded with powder in weight, a large-grained powder would occupy the whole ſpace or cavity of the inſtrument, which a ſmall-grained powder would only two-thirds fill: the conſequence of which is, that powder in its weakeſt ſtate would appear to be ſtrongeſt; and the reaſon is evident, becauſe there is a vacant ſpace between the powder and the body to be moved, with the ſmall grains; whereas the ſame weight of large grains would be in immediate contact with the body to be put in motion. But this is not the mode in which theſe inſtruments are generally uſed; for they are always filled with the powder to be tried, without any regard to weight; of courſe the ſmaller the grains, the ſtronger the powder will appear to be, without conſidering

that

that it is the ſuperior quantity, and not the quality, that is the occaſion of the additional force.

Regard to theſe obſervations ſhould be attended to even in the mortar, or any other machine for the like purpoſe; for it is well known, if the ball in a gun is not placed cloſe to the powder, its force will decreaſe in proportion as the ball is diſtant from the powder: but, as we ſhall have occaſion to diſcuſs this ſubject more particularly as we proceed, ſhall only obſerve here, that it will be always found, the greater the diſtance is between the powder and the body to be moved, the greater will be the proportional ſtrength of ſmall-grained powder; and vice verſa, the ſmaller the ſpace, the leſs will be the apparent force of the ſmall grains in proportion to the large.

Notwithſtanding the preceding experiments clearly and ſufficiently proved the very great advantage of ſmall-grained powder, yet, as I before obſerved, it is abſolutely neceſſary to bring the powder in contact with the body to be moved, in order to diſcover its real proportional ſtrength: to effect which, in the following experiments, I filled the vacant ſpace in the chamber of the mortar with barley meal, which in fact is the ſame thing as the ſhell itſelf touching the powder, and may be deemed a continuation of the ſhell, only that, being a ſoft, divided, compreſſible ſubſtance, it yielded a little to percuſſion: but then,

then, by its cloſe contact with every part of the ſurface of the powder, and the part of the chamber it occupied, no elaſtic fluid could poſſibly make its eſcape without the action of its whole force being exerted upon the ſhell.

Friction of the ſhell againſt the ſides of the mortar, was another obſtacle to more nice experiments: to obviate therefore this difficulty, I cut off from the three inch mortar before deſcribed, one diameter from the mouth, ſo that the only remaining cavity for the ſhell was half of its diameter, by which means there could be little if any friction; becauſe, at the inſtant of impulſe, a total diſunion of the two bodies muſt inevitably take place. Prepared in this manner, I proceeded as follows.

Experiment IV.

Elevation of the mortar fifty-eight degrees.

Diſtance of the ſhell's flight meaſured in YARDS.

1. The coarſe grains only of ordnance exerciſe powder - - - - - - - 48
2. Single Battel powder - - - - - - 124
3. Ordnance exerciſe powder paſſed thro' a fine ſieve, without ſeparating the duſt after grinding - - - - - - 120
4. Single Battel powder, partly pulveriſed, ditto - - - - - - - - - 140

5. Ordnance

5. Ordnance exerciſe, in large grains - 54
6. Single Battel, as bought - - - - 120
7. Single Battel partly pulveriſed - - 140
8. Ordnance exerciſe partly pulveriſed and ſeparated from the large grains, as in N° 3 - - - - - - - - 132

The quantity of powder here uſed was three drams, and the barley meal that filled the ſpace between the powder and ſhell was preſſed down with a moderate and equable force.

This experiment is not calculated to ſhew the proportionable ſtrength of the two powders, as the ſtates in which they were ſeverally tried did not conſpire to that purpoſe: but by a compariſon between this and Experiment V, in which the ſame quantity as well as quality of powder was made uſe of, it is evident that an intermediate body in the chamber of a mortar, where the chamber is not filled with powder (which ſeldom is the caſe) encreaſes its force in a very ſurpriſing degree.

I have frequently found by experience, that where there is a vacuum between the powder and ſhell, large grains have apparently more force than the ſmaller grains extracted from the ſame powder, when the diſtance between the ſhell and the powder is not great, and the chamber very deep and narrow; for inſtance, if the mortar is loaded with a coarſe-grained powder, ſo as to nearly

nearly touch the ſhell, and afterwards, with the ſame weight of ſmall-grained powder of the ſame quality, there will be found a vacant ſpace of greater magnitude in the chamber, between that powder and the ſhell, becauſe the ſmaller the grains are, the cloſer they lie to each other; of courſe, the ſpace occupied is leſs, and its exploſive force ſeems to be conſiderably abated by not being in contact with the ſhell: it is evident, therefore, that all ſorts of gunpowder ſhould be granulated alike, to determine its real ſtrength, and even in that ſtate it is poſſible one ſort may occupy more ſpace than another, from the quantity more or leſs of ſome of the compound ingredients, or ſolidity of the grains; both of which frequently happen: for which reaſon I think recourſe ſhould be had to ſome intermediate body between the powder and ſhell.

Another obvious reaſon for calling in the aid of ſuch an aſſiſtant is, that, as there is frequently an inequality in the ſhell, from ruſt or other cauſes, it may be placed in the bore of the piece ſo as to admit the eſcape of more of the elaſtic fluid at one time than another; which the intermediate body, ſuch as the above, fine ſaw-duſt, or the like ſubſtance, effectually prevents.

The reaſon why a real ſtrong powder is heavier than inferior powder, in proportion to its bulk, is, that it contains a larger quantity of nitre, which is by far the moſt weighty ingredient of which it is compoſed.

This obſervation at once points out the defect of all the common methods in uſe for trying the ſtrength of powder; thoſe in general having a determined ſpace to fill; conſequently, if two different powders are to be tried, although they actually are of the ſame ſtrength, yet if one is granulated finer than the other, it will occupy leſs room; of courſe it will take more in weight to fill a given ſpace: the effect of which will be in proportion to the difference of the ſize of the grains and the ſpace unoccupied. It is therefore abſolutely neceſſary, with ſuch ſort of powder provers, to reduce the grains of the large to the bulk of the ſmaller, or the whole to an impalpable powder: in which ſtate much attention is required, or errors will infallibly enſue, particularly in the laſt, in reſpect to loading.

Beſides the preference here given, and the reaſon of the advantages pointed out in the uſe of ſmall-grained powder, I ſhall in another place advance an additional argument, and ſuggeſt the probability of a more compound reaſon for the very great additional force gunpowder has in one ſtate than another.

Experiment V.

The ſame mortar; the quantity and quality of the powder, and the degrees of elevation, the ſame; but no intermediate body made uſe of

between the powder and ſhell, and the powder not rammed at all.

Diſtance of the projected ſhell meaſured in

	YARDS.
Single Battel powder pulveriſed - - -	21
Government exerciſe ditto ditto - - -	24
Single Battel whole grains - - - - -	3
Government exerciſe ditto pulveriſed -	26
Battle powder pulveriſed - - - - -	33

From this it is evident, that the vacuity between the powder and ſhell is the occaſion of the diminution of its force, and which muſt ever decreaſe in proportion as that vacuity increaſes: and here it appears, that as only one fourth part of the chamber was occupied, its force was not more than one fourth that in the laſt experiment, although the ſame powder was uſed.

The reaſon of the laſt charge throwing the ſhell with more force than the firſt, was certainly owing to ſome of the powder lying on the ſide of the bore nearer the ſhell, inſtead of its ſurface being even and parallel with the bottom of the chamber.

The cauſe of the pulveriſed powder exploding with more force in proportion to the whole-grained Battel, is no doubt owing to its ſurface being nearer to the ſhell, and part adhering to the ſides of the chamber not being at all rammed. When powder duſt is rammed, the greater part of it flies off unignited, as may be ſeen in Experiment VII.

EXPERIMENT VI.

The ſame mortar as before, elevated at an angle of ſixty degrees. The powder uſed was taken from ball cartridges as delivered from the ordnance ſtores; and the weight of each charge three drams.

The vacant part of the chamber filled with barley meal.

The purport of this experiment was to find in what ſtate gunpowder might be uſed to the greateſt advantage. In order to do this, I ſeparated the finer grains through a fine ſieve; from which all the duſt was ſifted; I then pounded ſome of the larger grains into a tolerably fine powder: and in theſe three different ſtates the effect was produced as follows:

Flight of the ſhell meaſured in - YARDS.

1. Powder reduced tolerably fine by trituration - - - - - - - - - 150
2. Small grains without duſt - - - 140
3. Large grains ditto - - - - - - 120
4. Powder as N° 1 - - - - - - - 148
5. Small grains as N° 2 - - - - - 132
6. Large grains as N° 3. - - - - - 126

It muſt be obſerved, each charge was gently preſſed down; but, as ſome inequality is unavoidable in that preſſure, allowance muſt be made

in

in reſpect to the range of the ſhell, from the ſame charge.

This experiment ſtill proves that the ball cartridge powder is conſiderably ſtronger than what is iſſued out by government for exerciſe; for, notwithſtanding in this experiment the mortar was elevated two degrees farther from its greateſt range than in Experiment IV. yet the diſtance of the ſhell's flight was greater.

It is alſo ſtronger than ſingle Battel powder, which is generally made uſe of for fowling. But the moſt eſſential knowledge we gain is, that the ſmaller the grains are, the greater is the force of powder; and that even mealed powder, or ſome reduced to an impalpable ſtate of fineneſs, and mixed in certain proportions, greatly augments its ſtrength.

Experiment VII.

As experiments of this ſort cannot be too much multiplied, or too frequently repeated, I proceeded to try, with the ſame degree of elevation as the laſt, the range of a ſhell of the ſame weight as the preceding, but with half an ounce of powder, inſtead of three drams as in the foregoing; and the ſpace between the powder and ſhell was left vacant: each charge was gently preſſed down, and the range of the ſhell meaſured in yards

	YARDS.
Government ball cartridge powder, in grains	76
Single Battel, whole grains	52
Single Battel, pulveriſed	20
Government, pulveriſed	20
Government, whole grains	86

This experiment perfectly anſwered my expectation; but I ſhould note that I ſeparated from the Government powder all the fine grains of the ſize of ſingle Battel, in order to try them in the next experiment. It may at once be perceived how erroneous is this method of trying the real ſtrength of gunpowder. The Government ball cartridge powder, in all my trials, has proved ſtronger than ſingle Battel, but not near ſo diſproportionate as in this mode, by reaſon of the great difference between the ſize of the grains, which muſt cauſe as great a diſproportion in the vacant part of the chamber: when each was reduced to a tolerable fine duſt, they appeared to have very little force, and the diſtance each threw the ſhell was equal.

Here it is again evident, the greater the ſpace is between the powder and the body to be moved, the leſs will be the impulſe; but in what given ratio, it may be difficult to aſcertain, becauſe there is a conſtant variation where the powders vary in the ſize of their grains; nor is it perhaps eſſentially neceſſary, in the uſeful practice

tice of fire arms, but only ſerves as a philoſophical enquiry. One thing, however, we learn, which is a ſerviceable knowledge in the uſe of mortars; that if the mortars are capable of containing in their chambers a larger quantity of powder than is ever required *, and no intermediate body made uſe of between the powder and the ſhell, the moſt advantageous powder to be uſed would be that of very large grains. In the pulveriſed ſtate of the powders laſt uſed, the ſpaces occupied being ſo nearly alike, nothing could well be determined, in reſpect to ſuperiority of ſtrength, without much nicety is obſerved in reduction of the grains of each to the ſame ſtate of pulveriſation; except in ſuch whoſe real ſtrength was more diſproportionate. Nor is the real ſtrength of powder aſcertained by this experiment, either in reſpect to quality or granulation; but vice verſa, becauſe, as I ſaid before, the mode is erroneous, though I believe the only one in general practice; yet it ſerves as a help to prove the fallacy of ſuch unprincipled and baſeleſs theory.

* Many, I believe, contain nearly double what is ever uſed in ſervice.

EXPERIMENT VIII.

I proceeded to try what proportion of force half the quantity of powder, with the vacant part of the chamber filled with ſome intermediate body, would have, that I might compare it with the laſt experiment, and endeavour from thence to draw ſome uſeful concluſions.

The elevation of the mortar, and the weight of the ſhell as before; the powder uſed only a quarter of an ounce, but of the ſame kind as the laſt.

Range of the ſhell in - -	YARDS.
Government ball cartridge powder, large grains, ſame as the laſt experiment -	76
Ditto, fine grains, ſeparated from the above - - - - - - - - - -	89
Single Battel, whole grains - - - -	76
Ditto, partly pulveriſed - - - - -	81

This experiment is replete with ſatisfaction, and effectually and decidedly proves the foundation of all the preceding aſſertions. Here not only the ſuperior advantage of the ordnance powder is again ſatisfactorily proved, but that, when there is no vacancy left between the ſhell and the powder, half the quantity of powder is ſufficient in a given ſpace, as herein ſpecified, to give

give a ball or ſhell nearly the ſame range, even in its weakeſt ſtate, which is in large grains; and by compariſon of the two experiments the curious reader will obſerve, that in the greateſt ſtrength of the powder, which is ſmall grains, there is a quadruple advantage in favour of the laſt method of loading a mortar with fine-grained powder.

But this is not the real advantage gained in practice, and only ſerves to ſhew that in one method of charging a mortar the powder cannot well be too fine, and in the other the coarſer it is granulated the better. To know, therefore, what real advantage is gained by the practice of the laſt method, it is neceſſary to take the abſolute ſtrength of the powder in its moſt advantageous ſtate in both caſes, and then it will be ſeen that the diſtances the ſhell was thrown were equal in both, viz. eighty-nine yards; but that in the latter experiment it was effected with half the weight of powder.

The utility of a matter of ſuch conſequence to Government need not here be inſiſted on; it is too obvious to waſte time, or to intrude on the reader's patience one moment longer than to ſay, upon this principle, founded on innumerable experimental facts, a ſaving of one-half, or at leaſt one-third, of the expenditure of government powder, in the uſe of mortars, and a proportion not inconſiderable in artillery of every denomination; the influence of which would alſo be ex-

tended, no doubt, to the general uſe of ſmall arms; and, as the origin of this treatiſe was partly as an aſſiſtant to the art of ſhooting flying, it needs not be ſaid, that what holds good in one caſe muſt be approved of in the other: the choice of powder therefore is to be made of ſuch whoſe weight has the leaſt ſuperficial meaſure; becauſe the ſame quantity of powder of the like quality, will only produce the ſame elaſtic fluid; of courſe, that which occupies the leaſt ſpace, muſt have leſs room for the extenſion of that fluid, whereby the leaſt of its force is abated; and that part which would only have filled a larger ſpace, and leſſened its force, ſerves as an additional impellent to the body to be put in motion.

Experiment IX.

After the preceding experiment (which ſufficiently proves, and leaves no doubt, but that the ſmaller powder is granulated, and even when part is reduced to duſt, if the grains wherein it is mixed are not exceedingly fine, its force is greatly augmented) I determined to try the ſtrength of it when reduced to an impalpable powder: for which purpoſe I prepared a quarter of an ounce of each, as follows; filling the vacant part of the mortar's chamber as before.

Range

Range of the ſhell in	YARDS.
Battel powder, fine grains ſeparated from the coarſe	89
Battel, coarſe grains, from the above	67
Battel, finely pulveriſed	32
Battel, to which the addition of four to the hundred of nitre, and one of charcoal, was mixed, and reduced together to an impalpable powder	75
Government ball cartridge powder, finely pulveriſed	32
Battel powder, not quite ſo finely pulveriſed as before	50

From this it is to be deduced, that powder loſes conſiderably of its ſtrength when reduced to a fine degree of pulveriſation: it therefore becomes an object of future enquiry, to what ſtate of fineneſs it might be brought, ſo as to produce the moſt powerful exploſion, as well as to know what quantity of duſt or mealed powder might be added, with the greateſt advantage, to granulated powder of any given ſize.

It is ſomewhat extraordinary, that the Battel powder, with which I had mixed an addition of nitre and charcoal, ſhould explode with ſuch a ſuperior force as to exceed the ſame powder in its various ſtates of pulveriſation: ſo that in fact the addition muſt have powerfully increaſed its ſtrength, and gave me a ſtrong deſire to know the proportion of the different conſtituent parts.

I therefore determined to analyſe it; for which purpoſe I took a quantity whoſe weight was eaſily divided into an hundred parts; this, with two other ſorts of powder of the ſame weight, I found, by previouſly drying in the ſun, had attracted humidity to the quantity of three quarters of a pound to a pound and a half in a hundred; which on a ſmall ſcale appears of little conſequence, yet if a barrel of powder was known to contain a pound and a half of water, nearly equal to a pint and a half, it would be ſuppoſed unfit for ſervice. After the analyſation of the powder, the decompoſition appeared as follows:

Nitre	75 1/3
Charcoal	12
Sulphur	12 2/3
	100
Additional Nitre	4
Ditto Charcoal	1
	105

So that the proportions of the powder then were,

Nitre	79 1/3
Charcoal	13
Sulphur	12 2/3

Much care was taken in this decompoſition, of courſe no material error can have happened; it

it muſt therefore be concluded that this compoſition is exceedingly good, and may ſerve as a hint to manufacturers.

While upon the ſubject of proportion of the conſtituent parts of gunpowder, it may amuſe and inſtruct the curious, who have not had an opportunity of inveſtigating the matter, to mention the reſult of the decompoſition of other powders uſed in the preceding experiments, and to paſs ſome obſervations thereon.

Government ball cartridge powder, decompoſed, produced, of

Nitre	75
Charcoal	13 $\frac{3}{4}$
Sulphur	11 $\frac{1}{4}$
	100

Government exerciſe powder, as delivered in barrels for military uſe, produced of nitre nearly 74 parts in the hundred; the other ingredients were proportioned as in the above.

Some very fine powder ſent me by a friend, for which he had given four ſhillings per pound, contained, of

Nitre	78
Charcoal	11
Sulphur	11

It is difficult perhaps to ſay what the component parts of gunpowder ſhould be, to produce the greateſt effect; but it is to be obſerved, *that* powder which contains moſt nitre, I have ever found to be the ſtrongeſt: not but it is poſſible to poſſeſs too much of that ingredient; for alone it will not deflagrate: it requires to be in contact with ſome phlogiſtic body, to produce inflammability: for this intention ſulphur and charcoal are two ſubſtances well calculated for the purpoſe; but it requires no more of them than is ſufficient to carry on that inflammation with rapidity, for in that the real ſtrength of powder chiefly conſiſts. It is from the nitre alone that the powerful elaſtic fluid is produced; therefore every particle of the other ingredients, more than ſufficient to explode the nitre in the ſame inſtant of time, may be looked upon as foreign to the ſubject, as a preventive to its greateſt effect, and a mere make-weight to the ſaleſman or manufacturer: yet it appears very ſtrange that this ſhould be an object; for if three or four pounds more of nitre, or even to the value of eight ſhillings worth in a hundred pounds weight, was added, it would not make the difference of one penny per pound in its real value. There is a degree of myſtery in every profeſſion, and it is not my buſineſs to unravel it: I only remark, that much of the expence appears to be in the labour of making fine-grained powder, ſuch as is generally uſed by ſportſmen; and yet, as an inſtance to the contrary, I procured a powder from ſome miners,

who

who had given ſixteen pence per pound for it at a country ſhop; it was granulated of a ſimilar ſize to ſingle Battel powder, was as hard nearly in its texture, but did not poſſeſs the like gloſs upon its ſurface: in its proof, which will be ſeen in ſome future experiment, it was evidently much inferior to that powder in ſtrength; but, by a judicious addition of nitre, intimately blended with it by grinding the whole to an impalpable powder, a ſtrength was produced equal to the Battel in the ſame form; and the additional expence of nitre was not at the rate of more than one penny in the pound: ſo that here was a powder not inferior to ſingle Battel, at the value of ſeventeen pence per pound; whereas, for that powder the retailers commonly charge two ſhillings: from this it is plain, that powder of equal goodneſs might be rendered to the public at a much cheaper rate.

Many attempts have been made to encreaſe the force of powder, by the addition of other ſubſtances, ſuch as ſalt of tartar, antimony, braſs duſt, ſpirits of wine, water, &c *. all of which produced a contrary effect; tho' we are aſſured by another author, that ſalt of tartar, judiciouſly mixed, powerfully encreaſes its force; but adds, humanity forbids revealing the ſecret. Many perſons erroneouſly conceive, that damp encreaſes the ſtrength of powder, becauſe they ſay the recoil

* See Thompſon on gunpowder, *Phil. Tranſ.* for 1781.

of

of a gun is greater in damp weather*: but I need not ſay the notion is too abſurd to require argument. It is a well known fact, that powder thoroughly dried, occaſions a great increaſe of force, and more ſo if uſed while hot; —the evident reaſon why the charge of a cannon is decreaſed after repeated firings.

Steam is certainly one of the moſt powerful agents in the uſe of mechanics, and perhaps no force is greater; but its action is not ſufficiently rapid to augment the ſtrength of powder by any mode of application: therefore we may conclude, every ſubſtance, hitherto diſcovered, ſerves only to reduce its powers. Small grains are abſolutely neceſſary to its perfection, but not any ſuperficial gloſs from a foreign body†; on the contrary, bruiſed powder is encreaſed in its ſtrength by that operation, and even when part is reduced to duſt, provided the grains before were not exceſſively fine. This will be ſhewn hereafter.—An experienced manufacturer aſſures me he would engage to make Government powder, of the ſame ſized grains with that of Battel, for the additional price of five ſhillings in the barrel; which would not encreaſe the expence three farthings in the pound, and in the end would be the means of a very conſiderable ſaving to the nation; for, having ſufficiently proved that coarſe powder has nearly

* See the Eſſay on ſhooting, p. 78.

† Some gunpowder is glazed by moving it in a cylinder with black lead.

one

one third leſs force than the ſame when reduced to ſmall grains, it is evident the nation would benefit by a reduction of the like quantity in expenditure.

Another thing is to be obſerved, as eſſentially neceſſary to the production of good powder, which is, obtaining nitre free from adulteration; and, as that is perhaps difficult, it is proper to cryſtalliſe it two or three times over, in order to purify it, and ſeparate it from ſea ſalt, with which it is too often intermixed.

I am credibly informed, that all Government powder is intended to be made of the ſame quality; and that which has been longeſt made, or confined in magazines, is what is delivered for exerciſe, being weakened by damp; the neweſt is reſerved for actual ſervice: but, as it moſt frequently happens, that in ſo large a quantity as our ſtores contain, ſome inequality in point of ſtrength will be obſerved in that delivered for the deſtruction of our enemies, to the great detriment of the ſervice, much attention ſhould be paid to its preſervation; or ſome plan adopted for an annual proof of powder throughout the kingdom. If an inſtrument was formed for the purpoſe of an eprouvette, a mortar of a ſmall ſize, whoſe contents are carefully noticed, every one of a ſimilar make and dimenſions muſt have the ſame effect, and, thereby fixing a ſtandard for good powder, the ſtrength of all would be readily aſcertained and compared; and ſuch as is not thought ſufficiently

ſtrong

ſtrong for ſervice, ſhould be laid by for exerciſe; and if any appears materially damaged, it ſhould be totally rejected, and the nitre ſeparated from it for further uſe.

To make this matter more clear, let us ſuppoſe a number of ſmall mortars made exactly ſimilar to each other, with balls fitted to them of the ſame diameter and weight; their effects will be equal; theſe ſhould be uſed as provers in all our arſenals and garriſons where there are perſons ſufficiently qualified for the purpoſe; and if a given angle of elevation is ſtrictly attended to, gunpowder would be uniformly proved to a great nicety, in which at preſent there is much defect; for it is not alone ſufficient that a certain quantity of powder is fired out of a mortar of a given caliber, but that the formation of ſuch mortars, in every particular, ſhould be carefully obſerved; for the ſmalleſt difference in the depth, diameter, or ſhape of the chamber, as well as the length of the mortar, will materially vary the effects of the ſame powder.

I heard an experienced officer of artillery once declare, that he has known a powder of apparent inferior quality, when fired from a ſmall mortar, and yet when proved from one of a larger caliber has been found to be exceedingly good. I will not take upon me to contradict the aſſertion; and doubt not but it might appear ſo, but for want of nice inveſtigation, was aſſigned to a wrong cauſe. Much care ſhould be taken to dry powder thoroughly before experiments of this ſort are put

in

in practice, or a larger portion of the charge may be ignited by a large mortar than a ſmall one, from a greater increaſe of heat. It ſhould alſo be obſerved, that long pieces inflame more of the charge than ſhort ones; and it is probable there are few in uſe which do not throw out ſome of the grains unfired.

Nitre is known to attract and retain moiſture; to prevent which, every precaution ſhould be taken to ſecure it from ſuch material injury, and which certainly might be effectually prevented by lining the caſks with thin ſheet copper. Every one knows the pores of wood are capable of extenſion and contraction; perhaps there is no better hygrometer; of courſe, every barrel, not containing a liquid, is greatly affected by the ſurrounding amoſphere, and will imbibe more or leſs humidity according to the ſituation and circumſtances; which a denſe body, ſuch as copper, for a lining would intirely prevent: the expence is not great, and would ſoon be reimburſed by the durability of powder in its primitive ſtate, and the caſks renewed again for the like purpoſe.

The beſt method of drying large quantities of powder, is moſt certainly by the heat of the ſun; but, as the influence of that luminary is not always to be procured for the momentary uſe of the ſportſman, whoſe expenditure is trifling, no better perhaps will be diſcovered than filling a common water plate with boiling water, the orifice of which being well corked, and the powder laid thereon,

thereon, the damp it contains will be diſſipated in a very ſhort time; and may be facilitated by ſtirring it frequently: after this operation, it ſhould be put into bottles, and ſecurely corked for uſe.

The common method of drying it, by a heated fire-ſhovel, is not only attended with danger, but may conduce to weaken its force; for it is well known, that ſulphur may be ſublimed by a leſs degree of heat than will explode powder.

Experiment X.

In order to throw as much light as poſſible on the ſubject, I proceeded to try what force equal parts of powder duſt and ſmall grains mixed together would produce. The elevation of the mortar, quantity of powder, &c. the ſame as before.

The firſt ſhot was made with Government ball cartridge powder, paſſed through the ſame ſieve as in Experiment VIII.: but in this the duſt was entirely ſeparated; whereas in that a ſmall quantity remained.

Range of the ſhell in - - - YARDS.

N° 1. Ball cartridge powder, very fine, without duſt - - - - - - - 91

N° 2. The miners powder, freed from duſt, and paſſed through the ſame ſieve as the laſt - - - 57

N° 3.

N° 3. Government ball cartridge powder, ſame as the firſt, mixed with an equal quantity of duſt - - - 55

N° 4. Single Battel, ſmall grains, ſeparated as above, and mixed with equal parts of duſt - - - - 41

We are to obſerve, from the reſult of this, there is no very material difference between N° 1 here, and N° 2 of Experiment VIII; only that where there remained a ſmall quantity of duſt, in the former, the effect was not quite ſo great; which ſeems to indicate, that when the grains are very ſmall, duſt appears to weaken its force. The miners powder, ſpoken of at large in a preceding page, is not much more than half as ſtrong as Government powder, as ſpecified in N° 2; and in N° 3 and 4, where there was an equal admixture of duſt and grains, a very conſiderable part of the force was deſtroyed.

EXPERIMENT XI.

In this the ſame quantity of powder, and in every other reſpect the ſame rules obſerved as were made uſe of in the laſt Experiment.

Range of the ſhell in - - - YARDS.

N° 1. Government ball cartridge powder, as delivered from the ordnance ſtores - - - - - - - - 78

N° 2.	Ditto, fine grains - - - - - -	80
N° 3.	Ditto, finer grains - - - - - -	90
N° 4.	Ditto, the ſame as N° 2 - - -	82
N° 5.	Ditto, very fine grains - - -	95
N° 6.	Battel powder in duſt - - - -	24
N° 7.	Ditto, in duſt, not preſſed down -	32

This clearly proves the advantage of ſmall-grained powder, and the gradual increaſe of additional force acquired in different degrees of granulation.

It alſo ſerves to ſhew the decreaſe of ſtrength, or the force loſt by wholly pulveriſing powder, by comparing this with other experiments with the ſame powder; and teaches us, that in ſuch a ſtate powder ſhould never be rammed or preſſed down, for in that caſe, great part of the charge is certainly blown out of the mortar without inflammation, not being able to ignite for want of a ſufficient quantity of air interſperſed through it. Large-grained powder, on the contrary, cannot well be too hard rammed, becauſe it brings all its grains more in contact with each other, occupies leſs ſpace, and yet leaves ſufficient interſtices for its ready inflammability.

Experiment XII.

In order to make a comparative view of the different degrees of ſtrength between Government beſt powder, and that of double and ſingle Battel,

Battel, I ſeparated from each the very fineſt grains, which for diſtinction I ſhall call ſuperfine, in order to diſtinguiſh it from that called finer or very fine in the laſt Experiment, which was conſiderably coarſer than this. After which, I tried how much additional weight of Government powder, as iſſued from the ordnance ſtores, was requiſite to produce a force equal to the ſuperfine grains.

The vacant part of the chamber filled with an intermediate body.

Range of the ſhell meaſured in - YARDS.	
Double Battel, ſuperfine grains, quarter of an ounce - - - - - - - - -	129
Single Battel, ſuperfine ditto, ditto - -	93
Government beſt ſuperfine ditto, ditto -	118
Government powder, as delivered from the ſtore, with fourteen grains weight additional - - - - - - - - -	85
Government ditto, with 20 grains additional weight - - - - - - - -	94
Government ditto, with 30 grains additional weight - - - - - - - -	107
Government ditto, with 40 grains additional weight - - - - - - - -	113
Government ditto, with 50 grains additional weight - - - - - - - -	119
Government ditto, with 55 grains additional weight - - - - - - - -	126

The double Battel powder here tried was Leiſter's, and was ſtronger than that uſed in the firſt and third Experiments.

From this experiment it is evident the granulation of powder cannot well be too ſmall.

It appears alſo, Government beſt powder is not ſo ſtrong as this double Battel. But a compariſon may now be drawn of the difference in point of ſtrength between Government powder in its two moſt oppoſite ſtates, as the regular gradation of encreaſed force with the additions are ſpecified; and where it will be found, that Government powder, in its original ſtate, required nearly fifty grains weight in addition to produce the ſame effect as the ſuperfine grains, which is only about one eleventh part leſs than half as much again, the given weight being a quarter of an ounce avoirdupoiſe.

This is ſo conſpicuouſly proved, that it admits not of the ſmalleſt doubt, but that the advantage of ſmall-grained powder is ſo great, as to be of ſerious conſideration; a matter of no ſmall conſequence, where the expenditure of that article is in any material quantity.

Experiment XIII.

In this I endeavoured to diſcover whether it was poſſible to granulate gunpowder ſo fine, as to loſe any part of its force; for which purpoſe I ground,

I ground, and ſeparated the grains of different ſizes from each other by ſieves of various textures: the minute grains, hereafter ſpecified, were ſuch as a very fine lawn ſieve only could retain, as nothing but an impalpable powder would paſs through it.

The weight of the powder, &c. the ſame as before.

Range of the ſhell meaſured in - YARDS.

N° 1. Government exerciſe powder, fine grains - - - - - - - - -	74
N° 2. Ditto, extremely fine, with ſome little duſt - - - - - - - -	49
N° 3. Ditto, the ſame as N° 1 - - - -	80
N° 4. Ditto, the ſame as N° 1, only what little duſt remained was ſeparated, as well as the minute grains -	86
N° 5. Ditto, finer grains than N° 1, but not ſo fine as the next - - -	105
N° 6. Ditto, the ſame as N° 2, only the minute grains and duſt carefully ſeparated from it - - - -	103

From the above we find that this powder is ſtronger than ſingle Battel, when the grains of each are paſſed through the ſame ſieve, which is the only true way of comparing and determining the real ſtrength of powder.

We learn alſo from this experiment, that there is no material difference between the two fineſt

ſtates of this powder; indeed it ſeems to have more force in N° 5 than in N° 6; and where any minute grains or duſt was left in, it apparently weakened it, as in N° 2 and N° 4.

It ſhould however be obſerved, that the coarſeſt of theſe ſeparations was finer than double Battel powder; and the fineſt ſo minutely ſmall, as ſcarcely perceptible to be in granulation. Hence we may conclude, that each grain of gunpowder ſhould be ſufficiently large to contain, in one compact body, or maſs, a certain quantity of each of its component parts: as well as that there ſhould be ſufficient interſtices between the grains to admit the fire through all its parts with celerity, and to contain a proportional quantity of air, as the greateſt agent to the action of fire. Now, let us take a view of gunpowder in its primitive ſtate, as a compound, when all the materials are ground, or pulveriſed to what is termed an impalpable powder, and intimately blended together, by a long proceſs of trituration. If we examine it by the naked eye, there ſeems to be nearly as much annihilation of particles as in a liquid; but if we attend to it more philoſophically, and bring in the aid of glaſſes, we then ſee each particle diſtinct and irregular in ſhape and ſize, but not in perfect unity; and which I look upon as abſolutely neceſſary to produce the greateſt capable effect; for this purpoſe ſome intermediate body muſt be made uſe of, whoſe ſolvent powers are capable of more intimately mixing,

mixing, and bringing each atom into a more uniform connexion with each other; but then there ſhould be no larger granulation of the aggregate maſs, than will leave ſufficient interſtices for the neceſſary proportion of air, and admiſſion of inſtant inflammation.

Experiment XIV.

In order to have a comparative view of the miners powder, ſuch as in Experiment X. with Government exerciſe powder, I loaded the ſame mortar as in the laſt, but with one dram more of powder, this being three drams: each charge was very hard rammed, and the vacant part of the chamber filled as before.

Range of the ſhell meaſured in - YARDS.	
Government exerciſe powder, as delivered from the ſtores - - - - - - - - -	93
The miners powder, as bought - - -	85
Ditto, the ſmall grains and duſt paſſed through a fine ſieve, after grinding -	86
Ditto, the ſame as the laſt, but ſeparate from the duſt - - - - - - - - -	97

By this we may perceive how inferior is the miners powder, making allowance for the difference of granulation; for even in its fineſt ſtate, it exceeded the ſtrength of the other very little; ſomething more indeed may be allowed, as ſmall-

grained powder is not encreaſed in its force, equal to that of large grains, by hard ramming.

The duſt is alſo here found to impede the force of this powder when in very ſmall grains, as in all the other experiments.

Having in the preceding experiments, I hope, proved, in the moſt ſatisfactory manner, the great unneceſſary waſte of gunpowder, by an erroneous method of preparation for Government uſe, and the ill-founded principle of loading our mortars; there needs no further argument on, or production of any more of the numerous experiments I have tried, to enforce a fact ſo obvious, and ſo much in the power of any perſons to ſatisfy themſelves in, who are curious in ſuch reſearches.

I ſhall therefore take my leave of this ſort of experiment, as what more could be ſaid on the ſubject, would only be a repetition of the foregoing pages. There are many things yet remaining, of no ſmall conſequence, as to the conſtruction of the different engines with which gunpowder is uſed. I ſhall therefore, without anticipating to the reader, endeavour to prove aſſertions on this head by experiments, or on philoſophical principles.

Firſt then, let us conſider in what ſituation the vent or touch-hole of a gun ought to be placed, ſo as to reap the greateſt advantage from it. Various are the opinions on this head. The excellent Mr. Muller, in his Treatiſe on Artillery,

vol.

vol. v. page 83, ſays, " It is imagined, and ap-
" pears viſibly demonſtrable, that if the vent
" was placed about the middle of the charge, the
" powder would be inflamed in leſs time than in
" any other ſituation;" yet upon trial, he found it contrary to the general expectation, as may be ſeen by peruſing that gentleman's works. However, in order to give a clearer idea of the ſeeming phenomenon, I ſhall ſtate an experiment repeatedly tried, and endeavour to reaſon thereon.

EXPERIMENT XV.

As the effects of gunpowder have been found to differ according to the ſituation of the charge and ſeat of the touch-hole, I procured a mortar, whoſe chamber contained three quarters of an ounce of muſket powder, in which I had three touch-holes drilled equidiſtant from each other; one cloſe to the bottom, another half-way up the chamber, and the third between the other two.

The quantity of powder uſed was three drams.

Range of the ſhell meaſured in - YARDS.

N° 1. Fired from the middle vent, the vacant part of the chamber filled with fine ſaw-duſt - - - - - 140

N° 2. Ditto, from the lower vent, ditto 151

N° 3. Ditto, from the upper vent, ditto 127

N° 4. Ditto, from the upper and lower vents together, Ditto - - - 96

N° 5. Ditto, the bottom of the chamber filled with ſaw-duſt, reaching nearly as far as the upper vent, ſo that the powder nearly filled the remaining part of the chamber; and a little ſaw-duſt on the top - - - - - - - - - 61

N° 6. Ditto, the lower vent without any ſaw-duſt - - - - - - - - 28

N° 7. Ditto, the ſame as N° 5, only without ſaw-duſt on the top, and with clay at the bottom - - - - - 47

N° 8. Ditto, the bottom of the chamber filled with clay as high as the middle vent; the upper part with ſaw-duſt - - - - - - - - 89

To each touch-hole ſcrew plugs were fitted, ſo that when fired from one, the others were ſtopped, except in N° 4.

The three firſt fires effectually prove that the vent is never placed ſo advantageouſly as at the bottom of the chamber, or as near it as circumſtances will admit of: and there is no doubt this rule will hold good in reſpect to every other ſort of engine in uſe, whoſe length of chace or bore does not many times exceed its diameter.

The fourth, ſeems to indicate, that much of the elaſtic fluid was loſt through the additional touch-hole,

hole, otherwiſe it certainly would have produced a ſuperior effect, as in the third, when fired from the upper vent only. The fifth and ſeventh I conceive differed intirely from the addition of the ſaw-duſt on the top of the powder in the former, which it required not, being raiſed ſufficiently high to touch the ſhell.

It was to be expected the ſeventh would have produced the greateſt effect, from having the bottom of the chamber filled with clay, which is a much more ſolid body; but, ſtrange as it may at firſt appear, that ſo ſmall a quantity of an intermediate ſubſtance ſhould have encreaſed the force of the former, yet it is eaſily accounted for: the elaſtic fluid not being able to eſcape till the ſhell was put in motion, whereas in the latter it certainly did, on every ſide of the ſhell; whoſe ſurface not being even, could not be brought to bear equally on the mouth of the chamber. From this we may conclude, that when a ball or ſhell does not fit abſolutely cloſe to the chamber or bore of a piece, an intermediate body is requiſite to ſupply that defect.

The eighth produced a greater force than the laſt two; but not ſo much as in any of the three firſt, where the charge was at the bottom of the chamber: from this it is evident, a certain depth of chamber in a mortar, adds conſiderably to the force of powder, provided there is an intermediate body between the powder and ſhell to fill the vacant ſpace in the chamber; and which may

be

be eaſily put into practice in throwing live ſhells *, with great advantage, as will be ſhewn in another place. It is the practice with us to leave that ſpace, in the chamber of a mortar not filled with powder, vacant, viz. no wadding is uſed, in order that the blaſt of the powder in the chamber may ſet fire to the fuſe of the ſhell; on the contrary, we are told the French formerly not only put a wad upon the powder, but alſo filled the reſt of the chamber with earth; in which caſe the fuſe muſt be lighted before the mortar is fired: this muſt be attended with great inconvenience and danger.

Having ſhewn that, contrary to moſt opinions, the force of powder is increaſed to a very great degree, in proportion to the capacity of that part of the chamber filled with an intermediate ſubſtance †, it only remains to find out what inter-

* Such as are prepared with a fuſe to be ignited by the exploſion of the powder in the mortar.

† It is well known the paper of a cartridge being left on the top of the powder, or rather along the ſide of the chamber, from the bottom to the top (which is meant by Mr. Muller, page 241) acts partly as an intermediate body, and muſt, according to the principle deduced from the preceding experiments, encreaſe the effects of powder; but not altogether for the reaſon aſſerted by that gentleman, who ſuſpected the additional force aroſe from the powder being brought nearer the ſhell, and leaving a ſpace unoccupied by powder at the bottom of the chamber; but in this he was miſtaken, becauſe the ſame paper, placed in the intermediate ſpace between the powder and ſhell, will produce a greater effect.

mediate

mediate body may be made uſe of, ſo as at the ſame time to admit of the blaſt of the powder in the chamber firing the fuſe with certainty. Upon this principle therefore, if a ſolid body, ſuch as a chump of wood, was placed in the middle of the chamber, ſurrounded by the powder, the additional force produced would be in proportion to the capacity of the unoccupied part of the chamber, and the dimenſions of the chump; but I have found by repeated experiments, where the introduction of the chump in that ſituation had brought the upper ſurface of the powder near to the ſhell, that the effect produced was not ſo great as when the chump was placed upon the powder immediately under the ſhell: which makes good what I before aſſerted; that a certain depth of chamber, with ſome intermediate body, produced a much greater degree of force, with the ſame quantity of powder, than a chamber of the ſame diameter, but ſufficiently ſhallow to bring the charge in contact with the ſhell; and which, for the ſatisfaction of my readers, I ſhall prove in the following experiment, in ſuch a manner as may be applicable to the general uſe and practice of mortars. But before I proceed, it may not be amiſs to take notice in this place of Mr. Thompſon's experiments, to diſcover the proper ſituation of the vent in gun-barrels, mentioned in the Philoſophical Tranſactions for 1781, vol. lxxi. part ii.; which experiments ſeem to prove, that the ſame quantity of the ſame powder, has the like

effect

effect nearly in a gun-barrel, let the ſituation of the vent be in what part of the chamber it may. It is true, the difference of charges produced different effects with the vent in different ſituations; but they were too trifling to draw any other concluſions from, than that which conſtantly happens from the ſame charge and ſame ſituation of the vent, which will always vary a little more or leſs, according to the ſmall variation of force unavoidably uſed in loading.

The accuracy with which Mr. Thompſon ſeems to have purſued his enquiries, leaves no room to doubt the fact of his aſſertions in reſpect to thoſe experiments by him mentioned; but I muſt beg leave to differ with him, in ſuppoſing the ſame effect will take place in every ſpecies of fire-arms; becauſe I have repeatedly proved the contrary is the fact in mortars. See Experiment XV. It is therefore natural to conclude, that the inflammation of confined powder is not ſo rapid as Mr. Robins and others have generally ſuppoſed, and that the progreſs of it is gradually encreaſed throughout the whole length of a bore or barrel; and Mr. Thompſon's experiments ſufficiently prove, that in moſt caſes, grains of powder are blown out unfired, but leſs in quantity when the weight of the ball is greater in proportion to the powder: and when no ball was uſed, the unignited powder was diſcharged in very conſiderable quantity. This appears almoſt poſitive proof of gradual inflammation, be-

cauſe the more weighty the ball is, the more elaſtic fluid muſt be generated before it can be put into motion; from which we may conclude, that the ſituation of the vent in a long cannon or a muſket, is of little conſequence, becauſe, whether the powder in the chamber is firſt ignited in the lower or upper part of the charge, the ball will give way when a ſufficient quantity of fluid is generated for that purpoſe. It is true, when the vent is placed at the bottom of the charge, the upper part, at firſt uninflamed, may receive an impulſe, and then becomes an additional weight to be removed, to effect which, an encreaſed quantity of fluid muſt be generated before the ball and uninflamed powder together is put in motion; of courſe the leſs quantity of powder will remain to be inflamed in its paſſage through the barrel. If this principle is allowed of, and of which I believe there is no doubt, we ſhall at once perceive the reaſon of the different effects in reſpect to the ſituation of the vent in a mortar, and perhaps in a howitzer, but in particular the former, whoſe length of chace does not exceed two or three times the diameter of the bore; for here the length of chace is not ſufficient to admit of much additional inflammation, after the ſhell is once put in motion, becauſe the diſtance it has to run before it becomes independent of the action of the powder is ſo ſhort. If therefore the vent communicates with the upper part of the charge, the ſhell is impelled

forwards

forwards as ſoon as there is ſufficient fluid generated to give it impulſe; and the ſhortneſs of the chace prevents much accumulation of force, or encreaſe of inflammation, while the ſhell is paſſing through the bore; and probably much of the lower part of the charge has not taken fire before the ſhell has quitted the mouth of the mortar.

If the vent is placed at the lower part of the chamber, there is the weight of part of the powder as well as that of the ſhell to be overcome, of courſe more powder is inflamed, at the moment of impulſe, than when the vent is at the top of the charge, and of courſe full as much in its paſſage through the bore; beſides this, it is probable the flame of fired powder paſſes more readily from the bottom to the top of the charge than in the reverſe direction, becauſe the air before the vent readily gives way, having a free paſſage through the barrel to make its eſcape, and admit of inſtant inflammation through the interſtices of the powder in that ſituation. But there is great reaſon to believe the ſame effect does not take place in reſpect to that part of the charge behind the vent, ſuppoſing the vent even to be nearly in the middle of the charge, becauſe the air in that part of the charge reſiſts the paſſage of the flame towards the breech; and, not being able to eſcape, it only can be compreſſed to a certain degree, and muſt impede the progreſs of inflammation backwards; ſo that we may conclude that the flame paſſes infinitely quicker through that part of the charge before

the

the vent, than in that behind it. Upon the whole, therefore, I conclude, when the vent is placed far from the breech, in ſhort pieces, ſuch as mortars, much of the powder behind the vent is uſeleſs, not being ignited before the ſhell quits the muzzle; whereas in long pieces, though the progreſs of inflammation is equally ſlow, yet the whole charge may be ignited before the ſhot becomes independent of its action. This is natural for us to conclude is the fact, becauſe we find the ſituation of the vent, in pieces of diſproportionate lengths, have different effects; and from which we may infer that mortars and other ſhort pieces ſhould not have their vent placed above one ſixth or one fifth of the length of the charge from the breech; whereas in long pieces, the ſituation of the vent is perhaps of no great moment, though one third or one fourth the depth of the charge from the breech might be beſt. Before I leave a ſubject of ſo much conſequence in the conſtruction of fire-arms of every denomination, I ſhall take the liberty of mentioning, that a long tube filled with coarſe-grained powder inflames much quicker than when filled with fine powder; and that when meal powder is driven into a tube, the inflammation is ſtill ſlower; but if a wire is introduced through the mealed powder, ſo as to compleatly perforate it, the inflammation is inſtantaneous; if on the contrary, the lower end is ſecurely ſtopped, the rapidity of the inflammation decreaſes. From theſe obſervations we may learn, that large-grained

powder is the fitteſt for priming artillery, becauſe the interſtices being larger, the admiſſion of the flame is quicker for that reaſon, as well as the air therein contained finding a more ready paſſage to eſcape; whereas, when the lower end of a tube is ſtopped, the air therein contained muſt vent itſelf at the mouth, and thereby obſtruct the progreſs of inflammation downwards.

Experiment XVI.

For the purpoſe of this experiment I took a four and a half inch mortar, the capacity of whoſe chamber contained rather more than four ounces of muſket powder, and whoſe diameter was one third that of the bore.

The angle of elevation was forty five degrees, and the diſtance of the ſhell's flight meaſured in

YARDS.

N° 1. A given weight of coarſe powder, which filled rather more than half the chamber, without any intermediate ſubſtance, except a ſmall bit of paper - - - 120

N° 2. Ditto, the ſame quantity of powder with a plug * of hard wood

* The plug was turned out of box wood, ſo as exactly to fit the bottom of the chamber, with a groove cut on one ſide, to communicate with the touch-hole, in order to fire the powder.

at

	at the bottom of the chamber, ſo as to bring the powder very near the ſhell - - - - - -	110
N° 3.	Ditto, the ſame, with a ſmall bit of paper between the powder and ſhell - - - - - - - -	120
N° 4.	The ſame quantity of powder, with no plug at bottom, but the vacancy at top filled with earth -	630
N° 5.	One fifth more of powder than thoſe preceding, and no intermediate body - - - - - -	200
N° 6.	The ſame quantity of powder as before, except N° 5, with a ſquare chump of wood on the top, reaching to the mouth of the chamber - - - - - -	350
N° 7.	The ſame quantity of powder as the laſt, but finer grains of the ſame powder, with the ſame chump on the top - - - - -	320

This experiment was repeated with larger quantities of powder to the ſame advantage, therefore it is uſeleſs to inſert a repetition; but only remark, that the larger the quantity of powder uſed, the leſs was the difference between the exploſions, when there was a vacant ſpace in the chamber, and when ſome intermediate body was made uſe of, and ſeemed to be in the proportion as follows:

Between two thirds of the chamber empty, and that vacancy filled with a ſquare chump as an intermediate body - - - - - - - - - -	1 to 3
Between half the chamber empty, and that vacancy filled with a ſquare chump - - - - - - - - -	1 to 2
Between one third of the chamber empty, and that vacancy filled with a ſquare chump - - - - - - -	2 to 3

So that the additional force from a ſquare chump ſeems to be nearly in the direct ratio of the ſpace occupied by powder: but it muſt be obſerved, that when the chamber was one third filled with powder, and the reſt with earth, the encreaſed force was full five to one.

This laſt experiment confirms all that has been ſaid or done on the ſubject before.

By comparing the 2d and 3d fire with the 1ſt, it will be perceived there is no advantage gained by bringing the powder in the chamber to touch the ſhell, by means of a falſe bottom to the chamber.

The 4th ſhews the great additional force when the empty ſpace is compleatly filled with a compact body.

The 5th informs us of the inferiority of force with a vacant ſpace, although one fifth more of powder was uſed.

The 6th and 7th are ſufficient proofs of the advantage of ſquare plugs or chumps, as there is free admiſſion

admiſſion on every ſide for the egreſſion of the fire, by which the fuſe is readily kindled, as was the caſe in this experiment, the ſhells having been previouſly prepared with fuſes for the purpoſe of trial.

It is neceſſary to obſerve, the reaſon why the 7th, which was loaded with ſmaller grains, did not project the ſhell further than N° 6, with the ſame plug, was evidently becauſe the ſmallneſs of the grains had encreaſed the vacancy in the chamber, by which the impulſe muſt be decreaſed, unleſs the plug had been proportionably larger. I ſhall here remark, that in other experiments, where the ſides of the ſquare plug were filled up with part of the powder, and even when the plug was perfectly covered, the exploſive force was never quite ſo great; yet I would recommend, for real ſervice, to fill the ſides of the plug with powder, for the more ready communication of fire to the fuſe of the ſhell.

GENERAL REMARKS,

Deduced from the foregoing EXPERIMENTS.

FIRST.

That much preference is to be given to ſmall granulated powder, when there is no vacancy between that and the body to be projected: which is applicable to all ſorts of fire-arms.

SECONDLY.

That where the capacity in the chamber of a mortar is greater than is ever requiſite to be filled with powder, ſome intermediate body is abſolutely neceſſary, to give the ſhell its greateſt impulſe.

THIRDLY.

That a ſquare plug of wood, or perhaps an octagonal one, is the fitteſt intermediate body to be placed between the charge of powder and the ſhell, in the real practice of mortars.

FOURTHLY.

That the moſt advantageous ſituation for the touch-hole, is nearer to the breech than to the center of the charge, in ſhort pieces; but not abſolutely cloſe to the former, in any ſort of fire-arms.

FIFTHLY.

That if neceſſity requires the uſe of large-grained powder, previous bruiſing it, ſo as to reduce ſome of its parts, or even a portion of it, into duſt, greatly encreaſes its ſtrength.

SIXTHLY.

That ſmall-grained powder is little encreaſed in force by any addition of duſt: and, where the granulation

granulation is extremely ſmall, the admiſſion of duſt weakens its powers.

It has been ſuppoſed by Mr. Robins, and other authors, that the elaſtic force produced by fired powder, is as the denſity of the fluid only, without conſidering the encreaſe of heat, when a larger quantity is fired together.

If the force of exploded powder was as the denſity only, it would not have half the effect it really has; whereas we find the effects are nearly as the quantities.

If a large quantity of fired powder produced no greater degree of heat than a ſmall one, it could not have the ſame proportional force; becauſe, if we ſuppoſe the heat is equally produced by every quantity, the action of powder would decreaſe in proportion as the quantity was encreaſed; that is, let us ſuppoſe a given quantity of powder produces an elaſtic fluid equal to 20, and that the heat occaſions a rarefaction equal to 30 more, the force of this quantity would be equal to 50; now if we ſuppoſe the quantity fired to be double, the elaſtic fluid would be equal to 40, but then, if this quantity gave no greater degree of heat, the rarefaction would be like the laſt, only 30; by which rule, this double quantity of powder would produce three tenths leſs proportional force; but this is contrary to all reaſon. The rarefaction, cauſed

by the intenſity of the heat, is a much more powerful agent than the denſity of the generated fluid. When powder is fired in an exhauſted receiver, the mercurial gauge ſinks by its effects, but moſtly riſes again when the heat is gone off, though never quite ſo high as before; which ſhews the elaſtic fluid is permanent, but not ſo powerful as the rarefaction.

Mr. Muller, with great propriety, ſays, the elaſtic force, produced by an exploſion of fired powder, is in the compound ratio of the denſity of the fluid, and the intenſity of heat: and, as the ſubject is ſo ably handled by that gentleman, I ſhall beg leave to refer thoſe who wiſh to be more enlightened upon it, to read his Theory of Gunpowder, as the generality of our readers will be contented with knowing the force is powerful, without inveſtigating the principles upon which it acts.

As ſufficient evidence of the goodneſs of Government powder has been proved experimentally, though contrary to the general opinion, it may be neceſſary to ſay, I by no means propoſe to infer a general refutation of ſuch a ſuppoſition: as unavoidable circumſtances occaſionally occur, by which its powers are conſiderably abated.

It often happens, that by miſmanagement, neglect, or accident, powder becomes conſiderably weakened in its exploſive force, and this as well in garriſon, as on board a ſhip, the conſequence of which is, that probably it is not diſcovered

till

till neceſſity calls it forth on actual ſervice; when, to the ſurpriſe of the artilleriſt, the cartridges, or ſame quantity of powder as uſual, does not produce the ſame effect. Government is too frequently condemned for delivering ſuch powder, and they are ſometimes at a loſs how to produce the deſired effect: although I hope and conclude this deficiency in the art of gunnery does not often happen in garriſons, becauſe they generally poſſeſs officers of the artillery. Yet it is well known it too frequently takes place in the navy, of which many inſtances may be produced in the laſt war: having heard many good and experienced officers of rank mention where their ſhot would not reach the enemy; yet the ſhot of the ſame weight from them did execution, and frequently went to a great diſtance beyond. Upon aſking the reaſon why the charge was not augmented; the anſwer was, their cartridges were previouſly filled with a regulated quantity. I will not pretend to ſay what degree of credit ſuch an anſwer will do a commanding officer. The fact is, few officers, except in the artillery line, know any thing about the exploſive force of gunpowder, or the action of great guns.

A captain of a ſhip is ſuppoſed to leave the direction of the cannon to an illiterate perſon, under the denomination of a Maſter Gunner, who has two or three deputies under him, called Gunners Mates, that are probably leſs acquainted with the ſubject than their maſter; how then is

it

it poſſible to expect any thing out of the common courſe of their confined practice?

Having once aſked a gunner, why his ſhot had ſo much leſs range than thoſe of the enemy, in a particular action laſt war? Why, Sir, the powder, it was not half ſo ſtrong.—Suppoſe this to be the caſe, why did you not charge with double allowance, or with ſuch an addition as would have proved effectual? The reply was, that might burſt the guns.—How ſo? if your powder does not prove ſo ſtrong as uſual, and does not carry a ball with the ſame velocity as that of the enemy, whoſe guns you ſay were of the ſame caliber; if you encreaſe the force by an additional weight of powder, you are not in more danger of burſting a gun, than if you loaded a piece with a leſs quantity of ſtronger powder that produced the ſame effect; for the ſame force is only required to produce the ſame effect, is a well-known maxim. The chamber, or that part of a gun where the powder is confined, receives a ſhock only proportionably equal to the impulſe of the ſhot: that is, according to the ratio of its reſpective ſurfaces. Suppoſe, for inſtance, the ſurface of the chamber to be 40 ſquare inches, and that of the ſhot to be only five, the whole chamber would bear a preſſure eight times greater than the ſhot; but then being eight times as large in its ſurface, every eighth part, or in other words every five inches ſquare, will bear a preſſure equal to the ball.—This reaſoning was

only

only anſwered by obſerving, it was not cuſtomary to encreaſe the charge beyond a certain quantity, and that it was a ſhame Government ſhould deliver ſuch powder. I will admit that the powder iſſued from the Ordnance ſtores is not always of equal ſtrength, although I believe it is not ſo generally bad as repreſented; yet even ſuppoſe it to be infinitely worſe, how eaſy is it for a perſon, who is at all acquainted with the theory of powder, to produce the deſired effect, with a powder of a very inferior quality!

How difficult a thing it is to turn people out of an old trodden path: and how vain the attempt, even for an unintereſted individual, to induce or perſuade perſons, by argument, to explore a new and unbeaten track, although it carries with it the ſtrongeſt conviction!

I am well aware of this difficulty, nor do I even poſſeſs the leaſt ſhadow of ſucceſs; but, unleſs good and ſubſtantial reaſons to the contrary are given, I cannot help thinking that the ſtrength of the Navy might be powerfully encreaſed, by a well-appointed corps of Marine Artillery. I know of very little uſe for our preſent marines, except to ſtand ſentry at the cabin door, or occaſionally to make a deſcent upon an enemy's coaſt: it is true they are frequently placed in the tops in action; but if we conſider how much more advantageouſly they might be uſed, were they trained to the art of gunnery, it would not admit of the ſmalleſt degree of heſitation. The

regularity

regularity of fire, with ſmall arms, is wholly uſeleſs on board ſhip; nor is there, perhaps, occaſion for muſketry at all, except in particular ſituations, unleſs there are more men than are required to work the ſhip, and the great guns and ſwivels. When that is the caſe, let any idler take a muſket; the meaneſt in capacity will very ſoon learn to prime and load, and will equally do for a promiſcuous fire, as well as the beſt diſciplined ſoldier; and, as muſkets are always prepared on board, they might be uſed as occaſion required. Upon this plan the Marines would be uſed in a double capacity; like the Artillery corps, they would be made acquainted with the uſe both of great guns and ſmall arms, and, I am confident, would be the moſt uſeful and formidable body of men in the ſervice: the additional expence to the nation would be little, if any, unleſs the number appointed to each ſhip was encreaſed.

If the complement was regulated by the force of the ſhip, and one private allowed to each gun, beſides commiſſioned and non-commiſſioned officers, there would be ſufficient at all times, allowing for ſickneſs or other non-effectives, to direct a broadſide; and it ſeldom happens that a ſhip is obliged to fight both ſides at once. Inſtead of muſkets, which only carry one ball at a time, and which take up the whole exertion of one man; I am of opinion there ſhould be as many ſwivels in the tops as may be convenient; for when it is conſidered that a ſwivel, carrying a pound ball, will

will throw 15 or 16 muſket bullets every fire, and ſo on in proportion to the caliber of the ſwivel, the great advantage it has over ſmall arms is evident, as two men in this way will throw, at leaſt, five times the number of balls. I know objections have been made to this method, on account of the balls diverging conſiderably; but then, as the object is large, and as this manner of fighting would never be uſed but in ſuch caſes, as muſketry, when ſhips come to cloſe quarters, there is no doubt of its efficacy: and theſe would be fired under the inſpection of the marine artillery. I ſhall here ſuggeſt a method of firing leaden bullets to a very great advantage, and which is well calculated for the uſe of ſhipping. I mean ſuch a gun as is ſometimes uſed in fortifications, called a wall piece; but inſtead of the bore being of ſufficient ſize to admit a three or four ounce ball, it ſhould be exactly the diameter of our muſkets, but made proportionably ſtrong, capable of reſiſting four times their charge; and, like the wall piece, fitted with a ſwivel, that it might be fixed into any part of the ſhip required; this being ſtocked and locked in the manner of a muſket, occupies but one man to uſe it; for, being fixed, and turning upon a double ſwivel, it is taken aim with exactly in the ſame manner as a portable gun, but with more certainty; having a reſt, which partly prevents the vibration of the body with the motion of the ſhip.

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This piece then is to be loaded with four muſket balls lying upon each other, as is evident from the ſize of the bore; but which are previouſly to be made up into cartridges, for the more expeditiouſly loading, and in which the ſame method of biting off the end for priming is to be adopted; the remainder to be ſhook into the piece, and the whole to be rammed down with an iron rod of ſufficient ſtrength. The advantage of ſuch a gun needs not be inſiſted on, as it carries four balls at once, equally true with a muſket, takes only one man to manage, and may be fired as often, and with equal certainty, as I have experienced with a ſimilar gun I had made for experiment ſake.

I know well what I am to expect from ſome of the old veteran officers in the navy, who may, perhaps, poſſeſs more courage than knowledge on the ſubject; and I am prepared to meet them.

They will of courſe ſay, Why ſhould we adopt new modes, when the old are ſufficient? there is no fear, we ſhall always keep pace with our enemies in the art of war: and why ſhould we not do as well as we always have done? In anſwer to this I aver, that, without improvements on our part, we ſhall be inſufficient to cope with our enemies; nor can we keep pace with them, unleſs there is more attention paid, and more encouragement given to inventions in that department; and this ſurely is a copious reaſon why we

ſhould not do as well as we have done before. It is evident our enemies improve faſter than we do, from the greater encouragement to elucidate the ſubject; and I wiſh ſome time hence we may not become as contemptible to them, as they were to us a century ago: to the Albion ſhore our eyes ſhould be directed by jealouſy, for we may have reaſon to dread the final accompliſhment of their revolution.

The great misfortune in this country, is the little reward given to inventive faculties, or encouragement to improvements in thoſe arts where a patent is uſeleſs. The difficulty of obtaining audience of the chiefs of departments, and the impoſſibility of procuring a fair and impartial inveſtigation of an invention, is an abſolute bar to improvement.

Before I leave the ſubject of Artillery, I cannot help obſerving how needleſs is the unneceſſary weight of many of our pieces of ordnance; and, notwithſtanding reſpectable authors on that head, we obſtinately continue, without reaſon, old rules laid down, founded on no one mathematical principle.

Our late-invented carronades is an object worth a moment's conſideration, as they might be rendered of the moſt eſſential ſervice. At preſent the complaint is, that, when heated, they fly about ſo much as to be very unmanageable: How can it be otherwiſe, when their trunnions, or axis of motion, is ſo erroneouſly formed as to ſituation; entirely

entirely contrary to every mechanical principle? The place of the trunnions, in our cannon, is not where they ought to be; for, inſtead of placing their upper ſide in a line with the centre of the bore, their centre ſhould be ſituated ſo as exactly to correſpond with the centre line of the bore; and there is no well-founded reaſon why they ſhould not be ſo, ſince they might be made equally ſtrong in that ſituation: and here originates the reaſon of light field pieces ſhaking their carriages. If then in theſe pieces, whoſe centre of motion is ſo little removed from being parallel to the centre line of the bore, the inconvenience is ſo powerfully felt, what muſt it be in ſome of the large carronades, where the ring on which they move in their carriage is ſeven or eight inches from that direction? In this ſituation, the piece, when fired, is for ever endeavouring to turn round its axis in the manner of a wheel, and the more powerfully ſo, according to the diſtance of the ring or trunnions from the centre of the bore, upon the well known principle of the Lever. If a piece ſo conſtructed, met with no reſiſtance from the carriage under its breech, viz. if it was mounted, for experiment, in ſuch a manner as to have free liberty of motion upon its axis, it would make ſeveral compleat revolutions before it would ſtop: but, as the hind part, or bed of the carriage, prevents its natural inclination of revolving upon its axis, the conſequence is, that part of the carriage is ſtruck with an amazing force; and if its ſtrength

is

is ſufficient to reſiſt the impulſe, the elaſticity of the frame or carriage impels it upwards, and forces it againſt the fore part, from whence it returns again. Thus are theſe ill-conſtructed pieces continually vibrating upon their own axes, which muſt almoſt render them unſerviceable. To paſs any further remarks, would only occupy more time than I can ſpare, and I ſhould deviate from my firſt plan of brevity; I ſhall therefore only add, that the inventor was neither a mathematician nor a mechanic. There is one method in which carronades might be rendered exceedingly deſtructive, and a ſhip made moſt formidable and invincible; but, as ſuch a practice ought not to be put in force except in the utmoſt neceſſity, I ſhall decline mentioning it.

How extraordinary it appears, that, amongſt ſo many ſcientific men, no method (that I know of) has been thought on, to render guns immediately ſerviceable that the enemy have endeavoured to make uſeleſs by ſpiking, or deſtroying the trunnious! That it is very practicable, there is no doubt; the ſpiking of a gun is of little conſequence; for although it is impoſſible to get the ſpike out by boring or otherwiſe, if it is made of hardened ſteel, as it ought to be; yet it is an eaſy matter to drill a new touch-hole at a ſmall diſtance from the old one; and that, by a very ſimple machine, one man would accompliſh in a ſmall ſpace of time; if this therefore was the only damage an enemy had done to their guns, upon evacuating a poſt,

how ſoon might the whole be made fit for uſe again!

To ſubſtitute falſe trunnions, or to make a gun re-ſerviceable in this caſe, is attended with more trouble; but that it may be done does not admit of a doubt.

There is another method ſometimes practiſed in order to deſtroy the uſe of cannon; which is driving a ſhot whoſe diameter is rather ſuperior to the caliber of the piece into the mouth: this however may frequently be blown out, by introducing a ſufficient quantity of powder at the vent. In this caſe however I would adviſe the gun to be diſmounted, and taken to a convenient place to make the attempt; for if the ſhot ſhould reſiſt a force ſuperior to the weakeſt part of the gun, it would inevitably burſt: not that a gun in the common mode of loading, where a ſhot by ſome accident is not rammed home, is ſo apt to burſt as is generally imagined; but that the actual place of leaſt reſiſtance will not bear the ſame force of powder as if the ball touched the powder is evident; and, what may appear more extraordinary to thoſe who have never conſidered the preſſure of fluids, which is the ſame as the elaſtic fluid cauſed by the exploſion of powder, is that the natural place of leaſt reſiſtance, or the part of the gun poſſeſſing the leaſt ſubſtance of metal, is not the actual place of leaſt reſiſtance: which is contrary to the general idea, and which I will endeavour to explain upon the true principle of mechanics, and

make it appear, that the greater the diſtance between the breech and the ball, the greater is the probability of burſting the gun.

If a gun is ſufficiently ſtrong in its chamber, or part containing the powder, to reſiſt the firſt ſhock of the exploſion, the elaſtic fluid endeavours to extend itſelf through the whole bore or chace of the gun; if it meets with any obſtacle, whoſe force is not equal to the place of leaſt reſiſtance in the piece, it is carried out with it, but if the obſtacle requires more force to move it than the place of leaſt reſiſtance in the gun, that part muſt inevitably give way.

According to the conſtruction of guns in general, the metal grows gradually thinner from or near the vent to the muzzle, and is there about half the ſubſtance of the former; it has therefore been the common opinion, that if a gun burſts by a ball ſticking faſt in the bore, the place which gives way will be the neareſt to the ball, becauſe the ſubſtance of the metal at that part is leſs than in any other behind the ball: but this idea is contrary to the laws of fluids; for, notwithſtanding that is moſt certainly the natural place of leaſt reſiſtance, or (in other words) of leaſt ſtrength; yet in fact, next to the breech, it becomes the actual part of the greateſt reſiſtance.

Whoever is at all acquainted with the action of compreſſed air, will at once perceive the aſſertion to be juſt, and well founded: the force acquired by the exploſion of gunpowder is very different

from the ſtroke of a ſolid body put in motion: for it is well known, the elaſtic fluid of fired powder, or rarefied air, preſſes equally and uniformly in a confined ſtate againſt a given ſurface; ſo that if that ſurface was divided into an infinite number of parts, each part would ſuſtain a force or preſſure according to the ratio of the ſquares of its reſpective ſurfaces; whereas the force of a ſolid body in motion acts only partially, affecting only that part immediately ſtruck, except by the tenacity of the part ſtruck to the parts in contact. Thus a ſmall weight, thrown by the hand againſt a moveable body, ſuch as a door, will put the door in motion upon its hinges; and yet, if the ſame weight was projected with ſufficient velocity to perforate the door, ſuch as from a gun, no viſible motion would be communicated to it. The reaſon of this is, that a body at reſt being ſtruck with another body, whoſe motion or velocity is ſo great as to eaſily paſs through ſuch body, there is not ſufficient time to communicate much of its motion to the body perforated: but it is not to be ſuppoſed that one body can perforate another without loſing part of its motion; becauſe even a ſheet of paper, through which a ball paſſes, would in ſome degree diminiſh its velocity by the laws of friction: for though we don't perceive any decreaſe of motion by the interpoſition of ſo flimſy a ſubſtance, yet, by encreaſing the number of ſheets of paper, the velocity would be gradually loſt, till the body became totally inert. Exactly in this manner

ner is a ball gradually impeded by its flight through the air; for every particle of that fluid to be removed, is a perpetual increaſe of friction: therefore, from the moment a projected body parts from the body that gave it impulſe, it may be deemed decreaſing in velocity.

It is a well-known law of nature, that no body can communicate motion to another without loſing the like quantity of its own; from which it is clear, a wall may receive a more violent ſhock from a cannon-ball with a certain degree of velocity than if it was greater; for if it paſſes through the wall, it has only communicated a part of its velocity; whereas, if it ſtuck in the wall its whole force is there exerted.

But to return to the action of the elaſtic fluid, produced from fired powder in a cylinder or barrel of a gun. To define ſuch action, we muſt call in the aid of mechanical powers. Let a cannon be loaded, and the ſhot ſtuck faſt in the caliber at ſome diſtance from the powder. Suppoſe then a cannon with a ſhot driven in ſufficiently hard to burſt it by the force of powder contained in the chamber: ſuppoſe the breech equal to 12,000 pounds weight, or capable of bearing a reſiſtance to a fluid 12,000 times more denſe than atmoſpheric air; then divide the ſpace between the breech and the ball into ten equal parts, whoſe reſpective ſurfaces are equal to that of the ball and the breech; conſequently, when the elaſtic fluid of the fired powder has extended itſelf over the whole ſurface,

every part equal to the ball, and the ball itſelf, bears a weight or preſſure equal to 1000 pounds each.

Now on firing the powder in the chamber, its elaſtic fluid inſtantly extends itſelf over the whole ſpace between the breech and the ball; but the ball now bears a twelfth part only of the preſſure, as its ſurface is only a twelfth part of the ſurface preſſed, which we will ſuppoſe not ſufficient to impel it forwards. Then let us ſuppoſe the ſurface equal to the ball at the breech capable of reſiſting a preſſure of 12,000 pounds, that next to the ball a preſſure of 9000, it cannot burſt at either of thoſe places, becauſe each is only preſſed with 1000 pound weight; but, as the next diviſion bears alſo the ſame preſſure, and is double the diſtance from the fulcrums, the breech and the ball, it is preſſed with a weight of 3000 pounds each; the third diviſions 4000, the fourth diviſions with 5000, the fifth diviſions with 6000; which makes together a preſſure equal to 18,000 from the ball to the centre; and the like muſt be added from the breech to the centre; which makes a preſſure in the middle between the breech and the ball equal to 36,000 pounds; for the whole ſpace where the elaſtic fluid is confined muſt be conſtrued into a double lever acting upon the two extremities as fulcrums; the branchiæ or arms whereof meeting in the centre; of courſe this becomes the place of leaſt reſiſtance, and where a gun muſt burſt, allowing ſome trifle for the difference

ference of the ſubſtance of the metal of a gun, as it recedes from the breech, which would make it burſt rather nearer the ſhot than the breech.

This may be demonſtrated in the following manner:—Let a bar of caſt-iron A. (Fig. 1) be ſupported by the upright pillars B b; near each end of the bar hang two heavy weights, one at C equal to 12,000 pounds, to repreſent the breech of the gun; and another at D equal to 9000, repreſenting the part of the gun where the ſhot is lodged, and which is the natural place of leaſt reſiſtance. The bar is then to be divided into ten equal parts; and, as we have ſeen the 12,000 pounds at C, and the 9000 at D, have not been able to break the bar, we will take away thoſe weights, and diſtribute 10,000 pounds along the bar, 1000 at each diviſion, in order to repreſent the elaſtic fluid preſſing equally over the whole ſurface between C and D; but, notwithſtanding there remains only 10,000 pounds ſuſpended to the bar, the middle is preſſed downward, equal to a weight of 30,000 pound; for, as the centre is the branchiæ of two levers, whoſe fulcrums are B b, the accumulated weight on the extremity of each is 15,000 pounds, acquired by the diſtance from the fulcrums, ſo that the actual place of leaſt reſiſtance is abſolutely in or near the centre. At F the force is only equal to 1000, at G 2000, at H 3000, at I 4000, at E 5000; which added together, makes the weight at the laſt-mentioned place equal to 15,000 pounds; here then the bar or gun muſt

inevitably give way in the direction pointed out by the dotted lines, as we ſuppoſed the place of greateſt reſiſtance only equal to 12,000 pounds weight: it is evident therefore that a cannon thus loaded does not give way at the natural place of leaſt reſiſtance, or where the metal is thinneſt: for if the ball is fixed into the gun by a power equal to 2000 pounds weight, at a diſtance from the breech equal to a ſurface ten times as great as that of the ball; notwithſtanding the natural place of leaſt reſiſtance ſhall be equal to 12,000, which is ſix times the force required to move the ball; yet, as we ſuppoſe the exploſive force of the powder with which the gun is loaded is equal to 10,000 pounds at the moment of exploſion in a ſpace equal to the ſurface of the ball, by the time the elaſtic fluid reaches the ball one tenth of its original force only preſſes againſt its ſurface, the whole force being equally diſtributed preſſes only with a force equal to 1000 pounds againſt each reſpective ſurface ſimilar to that of the ball; as the ball is therefore held faſt by a power of 2000, and is only preſſed againſt by a force of 1000, it does not give way, but the gun will infallibly burſt at the place before deſcribed, Hence it follows, that a ball being fixed in the bore of a cannon at a diſtance from the breech equal to ten times its own ſurface, and capable of reſiſting a preſſure of 2000 pounds, whereas the place of leaſt reſiſtance in the gun we ſuppoſed equal to 12,000, yet a ſufficient quantity of powder only ſhall be fired

to

to create a preſſure againſt the ball equal to 1000, notwithſtanding which the force will be ſufficient to burſt the gun. In this caſe therefore it is certain, if the ball had been fixed in only with a force rather exceeding that of the preſſure of the elaſtic fluid againſt its ſurface, which was 1000 pounds, it would have been ſufficient to burſt the gun, although the place of leaſt reſiſtance, or weakeſt part of the gun, was capable of reſiſting a force near twelve times as great: the place therefore of actual leaſt reſiſtance, is nearly in the middle between the ball and the breech, being acted upon there by the accumulated weight upon the mechanical principle of the lever, where the branchiæ are affected by weight or preſſure according to the ratio of its diſtance from the extremities, which are the fulcrums: had the ball therefore, whoſe force or weight was equal to 1000 pounds, been cloſe to the powder in the chamber, whoſe capacity is equal to double the ſurface of the ball, and whoſe force at the moment of exploſion was equal to 10,000, the ball would certainly be ſtruck with a force equal to one third of the whole, its ſurface bearing that proportion to the ſpace occupied by the powder; ſo that the force of 1000 pounds would not have held it faſt in this ſituation, but the ball would have been impelled forwards with a force ſuperior to 3000 pounds.

From this it is evident, the further a ball is from the powder in a gun, the ſmaller is the quantity of elaſtic fluid with which it is impreſſed

at

at the time of exploſion, and the greater is the danger of burſting a gun in the attempt to fire it out, if it has been driven in with any degree of force; and *vice verſa*, the ſmaller the ſpace occupied by powder, and the cloſer the ball is placed to it, the greater will be its impulſe. For inſtance, if a certain quantity of powder occupied half the ſpace of another, its force would be double: thus the denſities of the ſame quantity of elaſtic fluid contained in different capacities, are as thoſe capacities inverſely.

I have been obliged to dwell on this ſubject longer than uſual, in order to give it a thorough explanation, as it is contrary to moſt opinions I have yet met with; but may be demonſtrable in many other ways than that I have given.

GRAVITATION AND FRICTION.

THESE are two powerful opponents in projectiles, and are continually at work on a body in motion, in order to bring it to a ſtate of reſt. I particularly mention this, in order to refute two vulgar errors which I have frequently met with, in perſons one ſhould little ſuſpect ſuch erroneous ideas exiſted: one, that a ball fired from a gun always aſcended at firſt, forming an angle upwards from the mouth of the piece: the other, that when a ball ſtrikes another body in an oblique

oblique line, ſuch as water, its force is accumulated.

Contrary as theſe principles are to the laws of nature, many perſons, for want of turning their minds upon the ſubject, have laid them down as certain. I only, therefore, wiſh to aſk, what it is that ſtops a cannon-ball when once put in motion; and, if it at firſt aſcends, what brings it down again? If a ball was to receive additional impulſe from every body it ſtruck, it never could again return to a ſtate of reſt: but this is fallaciouſly contrary to all reaſon, either theoretical or experimental. Could we take away gravity, and remove our atmoſphere, then indeed the velocity of a ball, once put into motion, would never decreaſe, but would continue to revolve round the earth for ever; for, as no inanimate body can poſſibly move without ſome other body puts it in motion, ſo it is as impoſſible for a body to come to a ſtate of reſt, without the interference of another body; therefore, as all inanimate bodies are inert, we may ſafely ſay, when we ſee a pile of cannon-balls, that they would lie in the ſame place for ever motionleſs, without ſome agent put them in motion. Again, when we ſee a cannon-ball ſtop, after having been fired out of a piece of ordnance, we conclude that ſome other body has put a ſtop to its motion, and brought it again to a ſtate of reſt: and upon enquiry, we find it has proceeded from two cauſes; firſt, by the reſiſtance of the air, which is friction: and ſecondly, by gravitation. Every one knows, that if a ball is thrown

into

into the air, it returns again to the earth by its own gravity; and that its deſcent and aſcent are accompliſhed in the ſame ſpace of time; but if a cannon-ball would continue to go with the ſame velocity, as at the moment it quitted the piece, the action of gravity would be very ſmall; the reſiſting medium, however, through which the ball is forcing its way, is continually leſſening its velocity; and as that decreaſes, gravity increaſes, till the ball is brought to ſtrike the earth, from whence it rebounds; but with much abated force, from the violent friction of a body ſo much more denſe than air. Now every ball, in its flight or paſſage through the air, meets with a conſiderable reſiſtance at all times, yet it is by no means at all times alike; for we find by the barometer, it is one twenty-eighth or twenty-ninth part heavier, more or leſs, one day than another, of courſe is as much more denſe; conſequently adds as much friction to a ball, or any body moving in it.

Another circumſtance of no ſmall moment is to be conſidered, in the velocity of a ball through the air, which is as to its direction *; whether it is with the current of air againſt it, or at an angle with it, and the velocity of that current. No one can be out of doors in a high wind,

* This may frequently have occaſioned a ſuppoſed defect in Government powder; for the guns of a ſhip to windward of another, will always throw its balls fartheſt.

without

without obſerving much more difficulty in moving againſt, than with the wind; from which we may conclude, that the velocity of a ball greatly depends on the quantity and direction of the wind; beſides, as air is a fluid, and compreſſible, it muſt be infinitely more denſe at the time it blows hard, than in a calm. I mean in the current.

Theſe remarks I have found obvious by experiments with a rifle gun; for, on firing at a point blank * mark, or what was a point blank ſhot with the current of air, was not againſt it: the difference of which muſt be in proportion to the velocity of the current. Sometimes I have found it very conſiderable: if the wind is at right angles with the gun and the object, the ball will be carried, more or leſs, to the right, or left of the object, according to the ſituation and influence of the wind; for inſtance, I have fixed a rifle in a frame, moveable in a vertical as well as horizontal direction, ſo as to take a very exact and ſteady aim; and have fired it at an object at the diſtance of an hundred and forty yards, (a point blank diſtance) with the wind at right angles upon my left, and found the ſhot diverge to the right; then, altering my ſituation ſo as to

* Authors differ about the definition of the meaning, therefore it is neceſſary to explain what I mean. When a barrel of a gun is in the line with the object fired at, and there is no perceptible declination of the ball, the diſtance is within a point blank ſhot; and *vice verſa*.

bring

bring the wind upon my right, the ball has deviated as much to the left, and this as often as it was repeated, when the wind had any apparent force; and in proportion to its velocity. This obſervation may be uſeful to thoſe who are nice in the uſe of rifles, or other ball guns, and in the practice of great guns, as well as to the Sportſman.—Rain is another powerful obſtruction to the velocity of a ball, as water is infinitely more denſe than air, ſo that a ball will meet with a reſiſtance from it, in proportion to the quantity of water the air is charged with.

MUSKETS.

IT is with no ſmall degree of concern we perceive all the demands of Government are nearly ſupplied by contract; and that with perſons who have nothing to do with the making or preparing the objects in queſtion: this, I am credibly informed, has been the caſe ſometimes in reſpect to muſkets; and the grievance would not be great if it ſtopt here; but the fact is, that the original contractor lets it to another, reſerving a profit to himſelf, and ſo on to a third, and perhaps a fourth, before it gets into a maker's hands; the conſequence of which is, that the price allowed by Government is dwindled to three-fourths; by which means the quality of the article contracted

tracted for muſt be much inferior to the intent and meaning of the contract, or ſpecimen, or pattern delivered; as this article, in particular, will admit of an apparent ſimilar perfection, when, in reality, it is far inferior.

In the barrels, indeed, there is not much deceit, if they are properly proved; but in the locks there is certainly very great defect; a defect of the utmoſt conſequence; becauſe in that part depends the firing. It is no uncommon thing, after a field day of a battalion, to find one fifth or ſixth part of the muſkets remain unfired; many of which did not fire from the firſt: this is ſo well known to every military man, as to prevent refutation; and ſurely is of moſt material concern, and of the utmoſt conſequence; for if we have a nominal force of ten thouſand men in the field of battle, whereas only eight thouſand are of any uſe, becauſe their pieces are unſerviceable, and won't fire, it certainly becomes a matter of moment, and ought to be thoroughly attended to. In hopes, therefore, that ſome patriotic perſon of conſequence and weight will, on ſome future day, ſtep forward, and rectify a matter of ſuch national concern, I ſhall point out the reaſon of the defects aſſerted, and in what way they may, in a great meaſure, be obviated. The firſt buſineſs is to prevent ſo large a deduction from the original price allowed by Government, which muſt be the caſe, if it paſſes through the hands of deputy contractors; for I need not

ſay

ſay the manufacturer, who muſt alſo make a profit upon his work, cannot poſſibly give a lock the labour it ought to have beſtowed on it, unleſs he is allowed a proportional price.

Much attention ſhould be paid to the hardening the Steel, or Hammer; for if that is ſoft, no fire will be produced by the colliſion of the flint; becauſe the particles of ſteel ſeparated will be too large to be ſufficiently heated by the friction, to ignite the powder; the Steel, therefore, cannot be too hard, if the main-ſpring is ſufficiently ſtrong; becauſe, by the friction againſt the ſteel, the particles of the ſteel ſeparated are of an intenſe degree of heat, being in abſolute fuſion, and melted into perfect globules: but then ſome nicety ought to be obſerved between the proportional ſtrength of the main-ſpring, and what is termed the feather ſpring, which is that on which the hammer moves; for, unleſs there is ſufficient reſiſtance in the latter, it ſignifies little that the former does its duty. Again, if the main-ſpring is not ſufficiently ſtrong to overcome the reſiſtance of the feather ſpring, the hammer will not be thrown up. If both ſprings are too ſtrong, the flint is ſoon deſtroyed; and if too weak, no ſparks are produced: this laſt, indeed, is a defect of the worſt kind, againſt which there is no remedy; whereas, when the ſprings are over ſtrong, they always produce fire with a little additional expence of flints. The Tumbler and Sear ſhould, as well as the ſprings, be well and equally tempered;

pered; for if one is harder than the other, the ſofteſt will ſoon be cut to pieces, beſides the addition of friction in a part there ſhould be as little as poſſible. The ſear-ſpring ſhould not be too weak, in order that the ſear may be forced into the notches, or catches, of the tumbler, upon the half or full cock; for want of which, many melancholy accidents happen, eſpecially where the practice is to let down the full cock to the half cock, without going beyond the half cock, and drawing it back ſo as to hear the catch of the ſear in the tumbler; this is too commonly the ill-taught method amongſt ſoldiers, and, I am ſorry to ſay, has too often proved fatal in the field of ſport; for it very frequently happens in letting down the full cock to the half cock, with the fore-finger preſſing againſt the trigger, the ſear is prevented from ſliding into the notch of the tumbler, and, catching on the edge of the notch, is afterwards fired by a jar of the piece: and I believe there is ſcarcely a ſoldier or a ſportſman who has not ſeen this frequently happen, without being able to account for it, otherwiſe than ſuppoſing the gun muſt have been full cocked; for, on trying the piece again in a proper manner, found it was not poſſible to force it off from the half cock. Theſe obſervations are eſſentially neceſſary to the goodneſs of a lock, and, if duly attended to, will have the deſired effect; but this is only the plain and ſimple conſtruction, which has been much improved on in various

ways, though perhaps of no great utility in a piece of this kind, except in one particular, which is a roller to the feather ſpring, and is, in my opinion, more durable than the common make, as the friction of the parts are much leſſened, and not ſo liable to wear and be out of order. But, notwithſtanding much depends on the goodneſs of a lock, much alſo is requiſite in the choice of flints: nothing can be worſe than thoſe delivered to the army, which, according to the phraſe of a ſoldier, have no fire in them: the fact is, they are either ſo thick at the edge, as to bring too great a ſurface into contact with the ſteel to produce ſparks, or elſe too ſoft to cut the ſteel: dark-coloured ſemi-tranſparent flints are by much the beſt.

Having laid down ſome rules in reſpect to the requiſites neceſſary to form a muſket lock fit for ſervice, I ſhall ſuggeſt what I think would be an improvement on muſket barrels. There certainly is no neceſſity of making our barrels of ſo great a length, as it has been proved the difference of velocity is very inconſiderable, except in pieces of very diſproportionate lengths. It has been urged by ſome, that long pieces are neceſſary in a charge; but in this I ſee no reaſon, becauſe I believe it ſeldom happens, that the charged remains to receive the charge; but was it ſo, ſurely what is curtailed in the barrel might be added to the bayonet: beſides, a long barrel requires a greater proportion of powder, to give a proportional

tional velocity to the ball. The weight of our preſent muſket is about eleven pounds three-quarters: the length forty-two inches: and as the diameter of the bore is three-quarters of an inch nearly, it is fifty-ſix diameters long. Now if the bore was only ſeven-tenths of an inch, forty inches long would make the barrel fifty-ſeven one-tenth diameters in length; ſo that thirty-nine inches, with this bore, would make fifty-ſix diameters long, wanting one-fifth of an inch: therefore a muſket on this conſtruction would be three inches ſhorter than thoſe in preſent uſe, and their velocity nearly equal.

Inſtead, therefore, of a barrel whoſe bore admits a ball of fourteen to the pound, I would have the bore only ſufficiently large to take a ball of ſeventeen or eighteen to the pound, by which means two balls might be fired at once, as occaſion required: the weight of the muſket ſhould not be much leſs than at preſent; but then, as the barrel would be more ſubſtantial, an additional ſubſtance might be thrown towards the breech, without weakening the fore part too much; by which means it would not be near ſo top-heavy, and every motion of the manual exerciſe would be more rapid and ſmart, eſpecially the recovery from the preſent, the charge, and the ſecure, as well as the caſting about from the priming to load. It may be thought, perhaps, that ſuch a muſket, loaded with two balls, might recoil too much to be put into general uſe; but

this is not the caſe, for I have repeatedly fired ſuch a piece with two balls, and the weight of powder, of the beſt quality, one dram three-quarters; which, according to our former experiments, is ſtronger than two drams of large-grained muſket powder, and which gave a ſufficient velocity for any ſervice required. Here then is an advantage of great magnitude, for by this method one man would do the execution of two, and therefore the force in the field of battle might be called double what it uſually was. A muſket thus loaded carries the balls equally as true as when charged with a ſingle ball.

I could, therefore, wiſh to ſee one or two corps, in time of war, furniſhed with ſuch pieces, and, I am convinced, their utility would ſoon be diſcovered. It is well known, part of the American army uſed four balls, made up into a cartridge, one nearly the diameter of the bore, the other three were ſo ſmall as to make only that diameter when laterally in contact with each other, and yet their effects were ſeverely felt; ſeveral inſtances of which I had ocular proof of.

RIFLE GUNS.

VARIOUS are the opinions concerning the beſt formation of rifle barrels. I ſhall, therefore, venture to give mine, as far as I am able to judge

judge from experiments, and repeated trials, with ſuch pieces on different conſtructions. But firſt it will be neceſſary to mention what is to be underſtood by rifling a gun. Every barrel comes under that denomination, when it has ſeveral longitudinal grooves, or furrows cut in the inſide, or bore of the piece; the number of which varies according to the whim of the maker; in general from five to ten, but moſt commonly ſix or ſeven, the more I think the better, provided they are not too narrow: the eighth or tenth of an inch will be ſufficient, which may be regulated by the ſize of the bore; and the ridges and grooves ſhould be of equal breadth, and their ſurfaces flat, except what concavity the bore gives the ridges, and not brought to an edge, as has been recommended by an anonymous author on the ſubject, becauſe thoſe edges would be very liable to become ſerrated by ruſt, and other cauſes, and deſtroy its original intention: but theſe grooves are not cut in a ſtraight line for ball rifles.

Such, indeed, have been made for fowling-pieces, with an idea of throwing ſmall ſhot cloſer and farther; but without the leaſt foundation. The rifles now in queſtion are cut ſpirally, but without any general rule; for it is probable the makers, or at leaſt moſt of them, do not know the intent of ſuch a formation, or the principle on which it acts upon the ball: each groove, in moſt of the barrels I have met with, makes one

turn, or a turn and a half, in the whole length; which is conſiderably more than is neceſſary; and, if much care is not taken in loading, might pervert the intention, in ſuch pieces as are loaded at the muzzle, becauſe, as the ball is wrapped either in leather, or ſome ſuch ſubſtance, it might be cut to pieces by the violent friction, and the ball not affected as it ought: the intent of the ſpiral grooves is to give the ball a ſpinning motion, a revolution upon its own axis, which is ſuppoſed to render a ball leſs erring in its line of direction. Whether it has this quality to ſuch a ſuperior degree, more than a ſtraight-grooved rifle, or plain barrel, will be conſidered hereafter: be this as it may, there is certainly no neceſſity for giving more friction to the ball than is abſolutely neceſſary to produce that ſpinning motion in its flight through the air. Now, if we ſay in a barrel of three feet the grooves take one turn and a half, which is generally the caſe, the ball will have a hundred and fifty revolutions in the diſtance of a hundred yards; and, if we conſider the inſtant of time a ball is going ſuch a diſtance, the velocity of its revolutions is inconceivably great: inſtead, therefore, of making the ſpiral grooves to take one turn and a half in the length of three feet, I would give them half a turn only in that length; and ſo in proportion to other barrels of different dimenſions, which would occaſion the ball to revolve upon its axis fifty times in the diſtance of a hundred yards, and which would be

a very

a very conſiderable celerity, and full ſufficient for the purpoſe intended: a greater number of circumvolutions is not only uſeleſs, but injurious, and ſerves to impede the ball in its flight, by reaſon of the reſiſtance of the air, particularly when fired from ſuch rifles as are loaded at the breech, whoſe ball is ſomewhat larger than the diameter of the bore; and, being forced through the barrel by the preſſure of the elaſtic fluid, muſt receive a perfect impreſſion of the barrel, and thereby become laterally uneven in its ſurface, which muſt conſiderably increaſe the reſiſtance of the air.

No rifle gun will throw a ball with ſo much velocity as a plain barrel; not only on account of the additional reſiſtance of the air, againſt the uneven ſurface of the laſt-mentioned balls, but alſo the additional friction of the ball againſt the ſides of the bore: for the ſame reaſon, a rifle that is loaded at the mouth, will throw a ball farther than one that is loaded at the breech; but in general deviates more from the line of direction. When a ball quits the mouth of a piece, if it has taken the perfect impreſſion on its ſurface, it bears alike on every ſide; conſequently is not thrown more on one ſide than another, if due attention is paid to filing the mouth even, and at right angles with the bore; for if one ſide is the leaſt longer than another, the ball will touch on that ſide laſt, and will be thrown out of the line of direction; becauſe, having been ſtrongly com-

preſſed on every ſide, it will naturally recede from that preſſure the inſtant the ball leaves the ſide that is ſhorteſt, of courſe will, in a ſmall degree, diverge on that ſide. When a ball is conſiderably leſs than the bore, as in a muſket, it is impoſſible to ſay on which ſide it will diverge, becauſe that depends on the ſituation of the part the ball was laſt in contact with, on leaving the mouth of the piece. Upon this principle, therefore, a rifle loaded at the mouth will frequently deviate from the line of direction, without much attention is paid to the manner of loading, as I will endeavour to explain. I before mentioned, that rifles of this deſcription have their balls wrapped in ſomething to make them fit the bore exactly; but much depends on the proportional ſize of the ball to the bore, and the ſubſtance the ball is covered with; for it is not alone ſufficient that the cover of the ball bears againſt the ridges of the rifle, but that the covering ſhould be ſufficiently thick to fill up the grooves, by which means only the ball can be given the circumvolutions required, and the powder its full force.

In moſt of the guns of this kind I have examined, the diameter of the ball has been too great for that of the bore; the conſequence of which is, that it will only admit of a very thin covering, whereby the intention is fruſtrated; for though it may be ſufficient to give a ball the ſpiral turns in loading, yet it will not bear the reſiſtance neceſſary in the velocity acquired by the

the force of the powder, and of courſe the wrapper or covering of the ball is deſtroyed by the angles of the ridges, the ball becomes looſe, and the line of direction uncertain; not becauſe it loſes its revolution upon its axis, but becauſe it bears unequally or partially on one ſide of the bore.

It ſhould be obſerved, that where expedition is required, as in the army, the balls ſhould be tied up in their covers, (for which leather is the beſt) and well greaſed, to facilitate the loading, and leſſen the friction.

Before I leave the ſubject of rifle guns, I ſhall take the liberty of mentioning one I had made experimentally, on purpoſe to try in what form it would throw more balls than one: the diameter of the bore was ſuch as to admit of a covered ball of three to the ounce, or forty-eight to the pound: this piece I repeatedly tried with two and three balls, and had the ſatisfaction of finding it carried equally as true as when loaded with one only; ſo that there are three chances of hitting the object inſtead of one, as the balls deviated a little from each other, but not more from the line of direction, than a ſingle ball is found to do. The velocity of a ſingle ball from ſuch a piece is exceſſively great, as it may be fired with a proportion of powder almoſt equal to the weight of the ball. Upon this principle were moſt of the original rifles made; and ſuch were uſed by the Americans, which would throw a ball four hundred

dred yards point blank; whereas thoſe in common uſe will ſeldom exceed a hundred and fifty yards; ſo that what a ſmall ball loſes by the preſſure of the atmoſphere againſt its additional ſurface, in proportion to its weight, compared with a larger ball, is more than amply made up by a triple velocity; the advantage derived, is from the ſuperior proportion of powder ſuch a barrel may be loaded with, without any inconvenience; whereas no man would be able to bear the ſhock of a portable piece, whoſe diameter took a ball of an ounce, or three-quarters of an ounce, with the ſame proportion of powder.

Let us now enquire more particularly into the real advantage of rifles, or ſuch as are formed with ſpiral grooves. It is no uncommon thing to reaſon upon the effects, and point out the cauſes why one thing ſhould have the advantage of another, without proving the event.

It is aſſerted, that plain barrels double their balls, as it is termed; that is, the ball does not keep the ſame ſide foremoſt, as at the time it left the piece. Suppoſe this to be the caſe, it is by no means certain it alters the rectilineal direction of the ball, and muſt be founded on theory only; and I do imagine a rifle barrel, whoſe grooves are ſtraight, will throw a ball equally as true as thoſe of a ſpiral form; and, from an experiment I ſaw tried, do conclude a plain barrel might be made to throw a ball with as much certainty as a rifle. The reaſon a particular author on ſhooting gives

for

for balls deflecting, when fired from a plain barrel, is their rolling along the bore of the piece, which motion is continued in their flight through the air, and therefore deſtroys its rectilineal courſe. Refutation, without reaſon, is not my intention: neither do I wiſh to detract from the publications of others, but to endeavour to throw a ſpark of light on thoſe parts which appear obſcure.

Let us ſuppoſe a barrel loaded with a ball one tenth of an inch leſs in diameter than the bore of the piece, and a wadding of paper, ſuch as is generally uſed, placed between the powder and ball, and another of the ſame upon the ball, to prevent its running out; it is not poſſible for the ball to roll along the bore of the piece when fired, becauſe the friction of the ball againſt the wadding, by the extreme preſſure of the elaſtic fluid, would be infinitely greater than what is occaſioned by ſliding along the bore. But was this not the caſe, and that the ball did actually roll along in its paſſage through the bore, and continue that motion through the air, it does not appear a ſufficient cauſe to alter its rectilineal courſe, if the ball is round, and its ſurface equal.

The reaſon, therefore, of ſuch a ball deflecting, is certainly from repulſion. Endeavouring to avoid friction, it is continually changing its firſt line of direction within the barrel; but the inſtant it becomes independant of partial friction, on quitting the mouth of the piece, it continues unchangeable in the angle it then formed with the

axis

axis of the bore, except that occaſioned by gravitation. The nearer the diameter of a ball is to that of the bore, the leſs will be the angle from the line of direction; and *vice verſa*; which would not be the caſe if it was occaſioned by the ſuppoſed rolling motion along the caliber or bore of the piece.

A particular friend, who was curious in bullet guns, had a plain barrel made, which loaded at the breech, in the ſame manner as thoſe rifles which go under the denomination of Ferguſon's, from a gentleman of that name having a company of men armed with them laſt war in America: the principle is the ſame as others that load at the breech, but more expeditious; for by a complicated ſcrew, which is fixed to the guard, one turn of the ſcrew lowers the top of it, ſo as to be even with the lower ſide of the chamber; this opening on the upper part of the barrel, is the paſſage through which the ball and powder is introduced. The plain barrel I am now about to ſpeak of, was tried at the ſame time with a rifle of this make, and their dimenſions were alike in every reſpect, and I declare it was difficult to determine which had the advantage: the plain barrel ſeemed to throw the ball moſt exact, the firſt two or three ſhots, after which it was perceived to recoil much more than the other; this was partly owing to the ball being rather too large for the bore, by which means it was more elongated than it ought to be, and the friction

greater;

greater; for, in fact, the ball ought not to be the twentieth part of an inch larger than the bore; for it ſhould be no more compreſſed than ſufficient to bear, or touch equally alike on every ſide of the bore. From this experiment, it is manifeſt that the ſpiral grooves in a rifle are of no real uſe in directing the line of the ball, and that the ball is not particularly kept in its rectilineal courſe by revolving upon its axis. I do not pretend to deduce from this, that rifles are totally uſeleſs, but that the ſuppoſed advantage derived from the circumvolutions of the ball is baſeleſs; for although a plain barrel, ſuch as above deſcribed, will throw a ball equally true, yet it would not be poſſible to load it at the mouth, to be as certain as a rifle loaded in the ſame way, eſpecially after two or three fires; becauſe it becomes more obſtructed by the refuſe of the exploded powder, when the ball bears on every ſide, than when the parts in contact are partial; ſo that, upon the whole, a rifle barrel has the advantage for general uſe.

REGULATING THE CHARGE AND LINE OF DIRECTION OF BULLET GUNS.

IN reſpect to the charge of powder, requiſite for rifles, or other bullet guns, much depends on the weight of the piece and diameter of the bore: if the caliber is not above half an inch,

two

two thirds the weight of the ball, in powder, may be uſed; but leſs in proportion as the ball's diameter encreaſes. The bore of a rifle, or portable bullet gun, ſeldom admits of a ball of more than three-quarters of an ounce; the beſt regulation, therefore, for the charge of powder, is that quantity which the gun will explode, without diſagreeably affecting the ſhoulder, which may eaſily be diſcovered by firing it a few times; firſt beginning with a dram and a half, or ninety grains of Battel powder, and encreaſing the quantity, five grains at a time, till the purpoſe is anſwered. The powder with which a bullet gun is loaded, ſhould not be introduced in the common way, becauſe many of the grains adhere to the ſides of the bore, and obſtruct a well-covered ball from being rammed down with eaſe; in order to obviate this, the ſmall end of the ram-rod (which muſt be of ſteel) ſhould have a ſcrew, on to which a thimble or hollow cylinder ſhould be fitted, whoſe capacity will admit of two drams of fine powder, which is as much as will ever be required.

In loading, this is previouſly ſcrewed on to the ram-rod, and when filled with the quantity required, the piece is to be reverted, and the charger introduced till it touches the breech, preſſing it with the right hand till the gun is returned to its proper poſition, and then withdrawn: if this is done, there is no occaſion for any wadding between the powder and ball: the large end of the ram-rod ſhould be nearly of the ſize of the bore,

and

and excavated, ſo as to bear equally on the upper ſurface of the ball, by which means it will not deſtroy the orbicular form of the ball in ramming it down.

In order to ſet a rifle, as it is termed, that is, to find the centre line of the bore, there is but one accurate method, which is by practice; but it is not ſufficient that a gun ſhould be fired from the ſhoulder, even by the aſſiſtance of a reſt, for I need not ſay the unavoidable vibration of the body, or muſcular motion of the arms, will frequently cauſe the beſt ſet rifle to vary from the line of direction. For this purpoſe a ſtand ſhould be made, on which a frame ſhould be placed, whereon the barrel ſhould be ſecured by ſcrews, ſo that it may be eaſily fitted, or taken out; with an after piece to receive the end of the breech, which ſhould be contrived with a ſcrew, to be moveable in a vertical poſition, in order to raiſe or depreſs it; the frame ſhould alſo be made to move horizontally upon the ſtand, by means of a rack and wheel, ſo as to readily bring the ſight to the object; and in this ſituation to be fired by a port fire, or match; in which caſe the barrel can have no motion till fired; and if a pair of light wheels, of three feet and a half, or four feet diameter, were fixed to the ſtand, with a trail behind to reſt on the ground, it would be more commodious, and eaſily conveyed to the place of trial.

This is one neceſſary ſtep to find the centre line of the bore; but the moſt eſſential part remains,

mains, which is the adjuſting and fixing the ſights. Every perſon knows that a bullet gun has two ſights, one near the breech, the other near the muzzle; the front ſight ſhould be ſufficiently elevated, ſo that the viſionary ray paſſing over the breech ſight, ſhall be parallel with the bore. In the breech ſight a ſmall notch is to be cut, through which the muzzle ſight is brought to the object required: the muzzle ſight is immoveably fixed to the barrel; but the ſight at the breech is let into a groove, ſo as to ſlide either to the right or left, as occaſion may require, though not too eaſy, leſt the ſhock in firing ſhould change the poſition it was placed in; but ſufficiently tight to bear a gentle blow of a hammer. When all this is adjuſted, the barrel is to be fired at a ſmall mark in the centre of a broad ſurface, at the diſtance of a hundred yards, to obſerve the deflection of the ball, and, by repeated trials, move the breech ſight, till the horizontal line of direction is found, and if there is any declination in the vertical line, when the top of the muzzle ſight is diſcovered through the notch in the breech, a ſmall portion of that ſight muſt be taken off by degrees, with a file, till the viſionary line, and the centre line of the bore become parallel; then fix the breech ſight, by cloſing that part of the barrel that over-laps the baſe of the ſight; but firſt draw a line with the edge of a file acroſs the junction of the barrel and ſight, that it may again be rectified, ſhould it be accidentally moved from

from its true poſition. Few gunſmiths have the means of finding the centre line of the bore; nor will they be at the trouble of adjuſting the ſights in the manner deſcribed: therefore, whoever purchaſes a rifle for the purpoſe of being expert in the art, muſt adopt the method herein mentioned, if he wiſhes to hit an object with any degree of certainty. I have ſeen a gunſmith ſet, as he called it, twenty rifles in a day; whereas it will frequently take five or ſix hours to properly adjuſt the ſights of one. Beſides, it is not every day that is fit for this nice operation; there ſhould be no perceptible motion in the air, for ſuch will inevitably cauſe a variation in the flight of the ball, according to the quantity, and ſituation in reſpect to the angle, it makes with the ſhot's line. See experiment with a rifle gun, under the heads Gravitation and Friction.

FOWLING PIECES.

I now come to that part which is moſt intereſting to the generality of my readers; and ſhall endeavour to explain, in as conciſe a manner as poſſible, the advantages every ſportſman may adopt, in order (as they term it) to become a good ſhot.

I ſhall not run through pages with the uſeleſs, but too general method of directing the manufac-

tory of gun barrels, or mode of holding and carrying a gun, and will only touch on them as occaſion may require; but will aim at pointing out the formation of ſuch barrels as are moſt uſeful, and what may be expected they are capable of performing.

The rage for ſhooting was never at a higher pitch than at preſent; and, as the art of ſhooting flying is arrived at tolerable perfection, perhaps there needs no additional inſtruction towards annihilating the different ſpecies of game. To inſtruct a perſon to ſhoot well is impoſſible, becauſe coolneſs alone is requiſite: certain it is, one gun may have ſome advantages that another has not, and yet the beſt, put into the hands of an unſkilful perſon, will have little effect: on the contrary, we ſometimes ſee a game-keeper, or a farmer, killing every ſhot he makes, with a gun that appears not only uſeleſs, but dangerous to fire with: it is therefore the perſon, and not the gun, that does the moſt execution.

There is nothing, perhaps, perſons have more faith in than the goodneſs of their own gun: the diſtance it kills is incredible; the cloſeneſs of its carrying, or rather throwing ſhot, is inconceivable: in fact, its equal was never ſeen or heard of: ten or twenty grains of ſhot put into a card at ſixty yards is no uncommon thing, and the merits of the ſhooter and his gun bid defiance to rivalſhip: ſuch is the general language of ſportſmen.

I would not wiſh to put ſuch perſons out of conceit

conceit with their guns; but when I hear a perſon declare his gun is ſure at three or four ſcore yards, I am certain the meaſure is of his own making, or the ſhadow of one; a bare imagination of the brain. I do not pretend to ſay no gun will kill at that diſtance, for there is ſcarcely one made but will by mere accident bring down a partridge at eighty yards with a ſmall-ſized ſhot; but that no common length of barrel, ſuch as is generally uſed for ſhooting birds on wing, will throw ſhot compact enough to make ſure of killing at fifty yards: one or two grains of ſhot are not ſufficient to ſtrike a bird, to make certain of bringing it to the ground; for a bird is a much ſmaller object than it appears to be, when ſtript of its feathers, and poſſeſſes many parts not vital. Guns of ſix feet in the barrel, ſufficiently weighty to take a charge of four or five ounces of ſhot, and bear the action of a proportion of powder, will no doubt kill with certainty at a greater diſtance; but here ſixty or ſeventy yards is a great way: it is certain large ſhot will kill much farther than ſmall if it hits; but the larger the ſhot the fewer in number, conſequently the leſs chance of ſtriking.

Various and innumerable are the experiments I have made with barrels of all lengths and ſizes, from half an inch to one inch in the bore; and have ever found a ſmall diameter throw ſhot cloſer and with more velocity than a barrel of a larger bore, with the utmoſt charge each barrel would bear, ſo

as not diſagreeably to affect the ſhoulder by the recoil, provided their lengths in inches and weight did not exceed each other; becauſe it is impoſſible to give a barrel, whoſe bore is eight-tenths of an inch, a charge proportionable to one of ſix tenths, for no ſhoulder would be capable of bearing the recoil of three ounces and an half of ſhot, and an hundred and fifty-eight grains of powder, the charge of the former in proportion to the latter, which is two ounces of ſhot and ninety grains of powder; for, as action and reaction are equal and oppoſite, the large-bored gun would recoil nearly as much again, that is in proportion to their reſpective charges, which is about ſeven to four. If therefore we would have a gun, whoſe bore is one fourth larger than another, do the ſame execution, it muſt be of a proportional weight, and their reſpective charges meaſure the ſame depth in inches; for, unleſs this is obſerved, it ſignifies little to expect a large-bored gun will do the execution of a ſmaller one; for, except there are an equal number of ſhots within the ſame diameter, or near the centre line of the bore, it cannot throw the like quantity into a ſmall object at a given diſtance. In order therefore to find the neceſſary proportion of weight and charge of one gun to another, to do equal execution, we muſt know the weight and proper charge of a given barrel. Now it may be aſked, what is a proper charge? That quantity which the ſhoulder is ſenſible of, without being diſagreeably affected; for the more charge a gun is

capable

capable of bearing, the greater is the killing diſtance. Suppoſe, for inſtance, I have a barrel whoſe bore is ſix-tenths of an inch, its length three feet, and its weight four pounds and an half, the charge one dram and an half of powder, and two ounces of ſhot; what ought the proportional weight of a barrel and its charge to be whoſe bore is eight-tenths of an inch? Say, as two ounces of ſhot in a cylinder of ſix-tenths, meaſures two inches *, ſo does two inches of a cylinder of eight-tenths of an inch take three ounces and an half of ſhot; and, as ninety grains weight of powder is to two ounces of ſhot, ſo is an hundred fifty-eight grains to three ounces and an half of ſhot; and as two ounces of ſhot is to four pounds and an half, the weight of the ſmall barrel, ſo is three ounces and an half of ſhot to eight pounds nearly, the weight of the large barrel. This is the only method of giving a large-bored gun the ſame killing diſtance as that of a ſmaller, if their lengths are the ſame in inches. But if a gun of a larger bore than another is required to kill at the ſame diſtance with the ſame charge, the length of the barrel muſt be the ſame meaſured in diameter of the bore: thus a barrel of ſix-tenths of an inch, and three feet long, is ſixty diameters of the bore in length, whereas a barrel of eight-tenths bore, of

* Two inches is mentioned for the ſake of an equal number, whereas it only meaſures one inch nine-tenths of common ſhot N° 1, which is ſo near as to make no ſenſible difference.

ſixty diameters long, is four feet, which length ought to kill at forty yards, the killing diſtance of the three-feet barrel, when their charges are equal: but it muſt be remembered the velocities of the two barrels differ with the ſame charge, and that the ſmall barrel has the preference on that account; for if we ſuppoſe all the powder in each barrel is fired before it leave the mouth of the piece, the long barrel will require ſome additional weight of powder to give the ſhot the ſame degree of velocity, by overcoming the additional friction of ſo much ſuperior length, and decreaſe of the preſſure of the elaſtic fluid in ſo much larger a capacity. This however is the only method of making barrels at all ſimilar to each other in effects, whoſe bores are different: but it muſt be recollected, when the charge of a large-bored gun is to be increaſed in proportion to that of a ſmaller, according to the rule laid down, whoſe length in inches is the ſame, it is requiſite that the weight of the ſtock, as well as the barrel, ſhould be conſidered in the calculation.

From what has been ſaid, I will leave the judicious ſportſman to judge which of the two guns he would chuſe to be the companion of his amuſement; for if one gun in its ſtock ſhould weigh eight pounds, the other muſt weigh fourteen, to be loaded with its proper charge, or the reaction will be too ſeverely felt; and, after the expenditure of ſuch an additional, or I may ſay uſeleſs, quantity of ammunition, he gains no one advantage in the

art

art of ſhooting flying. If indeed a flock of birds are to be fired at, at a ſmall diſtance, the larger the quantity of ſhot the greater the chance. But what Herculean perſon is to be found, who is able to bear the weight of ſuch a gun for ſix or eight hours together, or to point it ſteadily at an object? If indeed he would wiſh rather to make up the deficiency of the charge by the length of the barrel, and carry one of four feet inſtead of three, it is certainly chuſing of the two evils the leaſt; but ſtill he gains no advantage, for a long gun is certainly more cumberſome, and by no means ſo readily brought to a point.

Large-bored guns will always diverge their ſhots more than thoſe of a ſmaller diameter; of courſe, a ſmall-bored gun has conſiderably the advantage when fired at a ſingle object.

When we ſpeak of the abilities of guns, we do not mean to ſay the cloſeſt carrying barrels are adapted alike for every ſhooter; for if a perſon is unſteady, and ſeldom ſtrikes a flying object, he has more chance of ſometimes killing with the ſkirting ſhots of a more ſcattering barrel. Nor is any particular gun calculated for every ſort of ſhooting: for woodcocks, a ſhort barrel, whoſe bore rather exceeds a medium, is beſt, becauſe it moſt commonly happens the coverts they lie in ſoon intercept the ſight, and require a quick unſteady fire, and frequently at a ſmall diſtance: on the contrary, for grous, or partridge, where the object is generally open, a barrel ſhould be longer, and

the bore ſmall, in order to bring down the object at a greater diſtance: however, in order to give the inexperienced ſportſman a more compleat idea, I ſhall ſubjoin a table of barrels, ſpecifying particularly what may be expected of their abilities.

If it is the wiſh of a ſhooter to kill at a great diſtance, he muſt encreaſe the weight of his gun; for it can only be done by length of barrel according to the diameters of the bore, and an additional quantity of powder and ſhot; for I muſt beg leave to differ in opinion with an author on the art of ſhooting flying, who aſſerts a ſhort barrel will kill as far as a long one. It is true, the difference of velocity is not great, where the charge is the ſame, and indeed an immoderate length of barrel might have an inferior velocity; but if it is meant that a gun of four or five feet will not kill further than one of three feet, of the ſame bore, the ſuppoſition is not well founded: velocity is not the object required in the art of ſhooting with ſmall ſhot; every barrel in uſe for that purpoſe has a ſufficient degree of velocity: compactneſs of throwing the ſhot, is the means by which birds are killed at a greater diſtance; and no ſportſman of experience will deny that a long barrel diverges its ſhot leſs than a ſhort one. Here then is the advantage of a long barrel, that it will with the ſame charge, according to the proportional difference of length, put into an object a greater number of ſhots, by which there is more chances of killing. Vide table of gun barrels, p. 115.

Thoſe

Thoſe who expect light guns, of three feet, or three feet and a half in the barrel, to throw ſhot ſufficiently cloſe to enſure a ſmall object at fifty or ſixty yards, are exceedingly miſtaken. It is no uncommon thing to hear a perſon declare his gun kills at that diſtance; but there is a great deal of difference between killing by accident, or with certainty; and if any ſuch perſon will only take the trouble to meaſure out that diſtance, and ſhoot at a ſheet of paper with the ſame charge he uſes in the field, he will be convinced of the fallacy of his ſuppoſition, unleſs, as I before ſaid, the weight of his gun is ſuch as to enable him to charge with a much larger quantity of ammunition than is generally uſed. 'Tis true, a gun that is ſix or ſeven feet long in the barrel, ſuch as is ſometimes made uſe of for killing wild fowl, will do execution with a tolerable degree of certainty at ſeventy yards, but then the weight is ſuch as enables it to take five or ſix ounces of ſhot, with a proper proportion of powder, and is only calculated for a reſt, to ſhoot at a ſtanding, or immoveable object, as few perſons are capable of lifting ſuch to their ſhoulder.

We frequently hear of gunſmiths advertiſements, wherein they ſet forth the ſurpriſing abilities of their guns, by a new-diſcovered method of boring: ſuch as killing a barn-door fowl, with certainty, at ſixty yards, &c.; nay I have even heard gentlemen aſſert they have ſeen it done: notwithſtanding which I will venture to declare it

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an impoſſibility, and that ſuch credulous perſons are duped and deceived by ſome ſtratagem they are not aware of; and I doubt not I could point it out, but as that is not my buſineſs, I ſhall leave the diſcovery of ſuch art to thoſe who have reaſon to complain of their credulity; and ſhall only ſay, that I have once or twice had an opportunity of examining guns of ſuch denomination, which I did with much attention. An acquaintance, not long ago, brought me a gun he had ſent to a gunſmith in London of the above deſcription (whoſe name I muſt beg leave to omit) to have it new bored, as it is termed, in order to kill with certainty at ſixty yards; but not being ſatisfied with its abilities in the field, though he aſſured me it had done wonders in the proving alley of the gunſmith, he deſired me to try it; which I readily aſſented to, having a great deſire to examine and gauge the bore with accuracy: but it was left with pointed injunctions not to take out the breech, becauſe he was told that it would injure the barrel; but, as I foreſaw the intention of this deſire from the gunſmith was only to prevent a thorough examination, and being too well acquainted with the ſubject to give credit to ſuch a ſuppoſition, I without heſitation immediately placed the barrel in a vice, unſcrewed the breech, and cleaned it with care, in order to gauge it with much circumſpection: the reſult of which was, that in my opinion it is probable the barrel had never undergone any alteration in the bore from

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the original make, for it differed not in the ſmalleſt degree from the general formation of common barrels.

The barrel in length was nearly three feet three inches, its bore in diameter about five-eighths of an inch, and the chaſe or whole length of the bore of a cylindric conſtruction, except at the breech for about two inches from the vent, which was about the thirtieth part of an inch larger.

As the bore, therefore, of this wonderful gun correſponded with many I had by me, in reſpect to formation, there was no apparent reaſon why it ſhould ſhoot to more advantage: however, that I might not draw concluſions even from well-grounded theory, I determined to try the fact; for which purpoſe I fixed the barrel in my rifle frame ſpoken of before, ſo that when aim was taken, it remained immoveable, being fired by a match inſtead of a lock; after ſeveral trials with different loads, I took it out, and placed in its room a barrel of my own, made by my directions by Wheeler of Birmingham; which was three feet only in length, the diameter of the bore ſix-tenths of an inch, the make perfectly cylindrical, except at the breech, which was in a ſmall degree larger, but ſo trifling as ſcarcely to be meaſurable; and, according to my expectation, found it throw the ſhot much cloſer than the laſt barrel, more ſo even than I could have imagined; but the reaſon is that this barrel is ſomewhat heavier, of courſe admitted exactly the ſame charge as the other, which

which was rather larger in the bore: this I found by firing both from my ſhoulder; and this exactly correſponded with my principle of guns; for, notwithſtanding the former barrel was ſixty-two diameters long, and the latter only ſixty, it could not poſſibly throw ſo many ſhots into the ſheet of paper, without an encreaſe of charge, and that could not be given it without it had ſome additional weight. After what has been ſaid, founded on juſt experiment, it is needleſs to animadvert on the fallacy and impoſition of ſuch pretenders to improvement, or the credulity of the ignorant; and I will be bold to ſay, that no gunſmith will ever give a barrel greater power than thoſe of a cylindric make. The deſideratum in the art of ſhooting with ſmall ſhot, is the compactneſs of the grains; velocity might eaſily be given if wanted (could the diverging quality be reduced) by taking away a portion of the quantity of ſhot, or uſing that of a much larger ſize; for if a method could be diſcovered to throw the whole body of ſhot into half the ſpace, half the quantity would have the ſame effect: but of this I deſpair; tho' indeed it ſeems needleſs to require it, as the art of ſhooting is become generally diffuſed throughout this kingdom, and the deſtruction of game is fully ſufficient already.

However, let us conſider for a moment the reaſon of ſhots diverging from the line of direction, as it may lead us to an additional proof of the ſuperior advantage of ſmall bored guns. If a

charge

charge of ſmall ſhot could be fired from a gun in a non-reſiſting medium, they would not ſeparate from each other, unleſs they poſſeſſed a great degree of elaſtic force; which, after being compreſſed, might act, every individual ſhot endeavouring to regain its original form; but, as lead is nearly non-elaſtic, this cannot happen. It is therefore evident, that the air alone is the cauſe of ſhot being thrown in ſo divided a form; for, the inſtant it leaves the mouth of the piece, the preſſure of air againſt the fore part of the body of the charge, by its reſiſting quality paſſes through the interſtices of the body with a force in proportion to the velocity of the ſhot, by which they are divided ſufficiently from each other to admit of free paſſage for the compreſſed air; ſo that the origin of the ſhots diverging, is at the inſtant they quit the mouth of the piece, when every individual grain becomes independent of each other, and continues in that line the air had at firſt occaſioned it to move in, except what it deviates in by the action of gravity. Now if we conſider how ſmall a deviation from the line of direction at the muzzle, makes a conſiderable angle at a diſtance, we ſhall eaſily perceive how impoſſible it is for any barrel to be certain of killing at the diſtance many people aſſert without foundation.

Suppoſe the exterior ſhots diverge in the firſt inſtant, ſufficient only to make one fifth part of an inch in the firſt foot, which appears very little, yet when the angle of variation is continued to a hundred

hundred and twenty feet, or forty yards, thoſe ſhot will then be found to deviate from the line of the bore two feet; by which means the whole charge will cover a ſurface equal to four feet in diameter, or twelve feet in circumference. Now as there muſt be more ſhot lying in the centre line of the bore of a charge in a ſmall-bored gun, than in a large, except the depth of the charges are equal, it is evident more ſhot will be thrown towards the centre of the object by a ſmall-bored gun, than by a large one. If a charge of ſmall ſhot could with any degree of certainty be regularly diſtributed over the ſurface of three or four feet diameter, at forty or fifty yards, no bird could poſſibly eſcape at that diſtance: but, by ſome occult cauſe, there is no regularity in the range of ſhot; the ſame barrel is found to throw into an object at one time double the quantity of another; for which reaſon, from a ſingle trial of ſkill, or compariſon of barrels, nothing can be determined; at leaſt twenty diſcharges of each muſt be given to prove a ſuperiority.

It is no uncommon opinion with ſome perſons, that ſhot croſs each other in their flight through the air, and which they believe to be the cauſe of their being thrown in ſo divided a ſtate; but ſo ridiculous an idea deſerves no comment. Some guns indeed frequently lump their ſhots, as it is called, that is, two or three grains continue in contact; but this ſeldom happens but in very weighty ſmall-bored barrels, whoſe depth of

charge is very conſiderable, by which means the weight of the ſhot powerfully reſiſts the action of the powder, and ſome of thoſe next the powder become heated and eaſily compreſſed, and are probably afterwards kept together by attraction of coheſion.—Now and then I have met with a gun not exactly bored true, having a contraction in the middle. This is an extreme defect; but ſeldom happens except in long barrels, perhaps from being bored at both ends*; it not only makes the gun recoil more, but the ſhots are thrown out of their ſpherical ſhape, by being preſſed too hard againſt each other in paſſing that narrow part; which muſt impede their flight, and may endanger the burſting of a thin barrel.

It is no uncommon thing for a gunſmith to ſend with a new gun a ſort of certificate of its goodneſs, that is, a ſheet or two of paper, ſaid to be perforated by the ſhot at ſuch a diſtance; but it never happens to do the like again in the purchaſer's hands; for which two reaſons may be aſſigned: firſt, that the diſtance ſpecified is rather more than it really was, or, ſecondly, that it was loaded with a larger charge than any gentleman chooſes to bear the ſhock of, and perhaps of that a large proportion of ſhot, which though it had velocity enough to pierce the paper, would not kill a bird.——I hope what I have ſaid upon the

* I mean, when the bore is opened or poliſhed by the gun finiſher, not that this is ever done by the maker.

ſubject

ſubject of guns throwing ſhot will be thought ſufficient, and ſerve to prevent expectations of impoſſibilities, grounded only on the errors or impoſitions of weak and fraudulent minds. When aſſertions carry probability with them, ſome credit may be given, but ocular proof is beſt.

A gunſmith of fame in Dublin was ordered to make me a gun; when it was ſent home, I was aſſured of its goodneſs, and the proof ſtamp was on the barrel; but, to my utter aſtoniſhment, when I was going to try it, there was no touch-hole. How my friend Partrick contrived to prove it, is difficult to diſcover, and I heartily wiſh he may obtain a patent, to prevent the like practice in this country.

In order to make a comparative view of barrels of different lengths, bores, and killing diſtances, it will be neceſſary to take ſome barrel as a ſtandard, whoſe charge and killing diſtance is well aſcertained.

It muſt alſo be underſtood, that I have never been able to diſcover, with preciſion, any fixed ratio of the killing diſtances between barrels of different lengths, but of the ſame bore and weight, loaded with the ſame charge. It has been conjectured by ſome perſons, that the killing diſtance of one barrel is to another, of equal bore and weight, as it is inches longer doubled in yards; but this conſiderably exceeds my experiments. The velocity of one barrel more than another makes a variation at different diſtances. I have found the pro-

portion

portion is not ſo great when one barrel conſiderably exceeds another in length. I ſhall therefore, upon an average, ſuppoſe that one barrel will exceed another only in the proportion of one yard to an inch, and which I do imagine will be found tolerably correct.

It muſt likewiſe be remembered, that what is meant by the killing diſtance, is that which a barrel will throw ſmall-ſized ſhot ſufficiently cloſe to be certain of killing a middle-ſized bird; beyond which it becomes a chance, and that chance is greater or ſmaller according to the increaſed angles of the ſhot's line, and the decreaſe of velocity.

Before I deſcribe the table, I ſhall remark, that although the three firſt barrels therein ſpecified carry with eaſe their reſpective charges, yet I would not recommend any perſon to try the ſix laſt barrels with their proper charges, except numbers 4, 5, 6, when mounted, weigh eleven pounds, and 7, 8, 9, fourteen pounds. I muſt alſo remark, that the utmoſt quantity of ſhot any gun is capable of being fired with for pleaſure, whoſe weight is under eight pounds, is a hundred and ſixty grains weight of ſhot for every tenth of an inch of the diameter of the bore: thus two ounces of ſhot, N° 1 is nine hundred and ſixty grains weight, which, divided by the diameter of a bore of ſix-tenths of an inch, gives a hundred and ſixty grains for each tenth of an inch, and ſo on in proportion. The quantity of powder is cal-

culated in the ſame manner, and is fifteen grains weight to each tenth of an inch in diameter, or eleven and a quarter grains to each quarter of an ounce of ſhot.—Having premiſed thus much, the following table will be better underſtood.

A gun ſhould put into a ſheet of paper of twenty-four inches ſquare, ſeventy grains of ſhot at a medium, or at leaſt the ſeventh part of a charge of two ounces of ſhot N° 1 Patent, which contains 448: but to prove this effectually, a gun ſhould be tried from twelve to twenty times, from a fixed ſtand, in order to aſcertain it with accuracy. If a gun is found to put into the mark deſcribed leſs than the ſeventh part of the charge at a given diſtance, it muſt be tried at leſs diſtances; and that diſtance at which it is found to throw in ſeventy grains on a medium only, is the greateſt killing diſtance: but regard muſt be had to the proportion of powder ſpecified in the table, for it ſignifies little to ſhoot at a fixed object experimentally, with a different charge than is intended to be uſed in the field.

A TABLE

A TABLE of Gun Barrels, shewing their respective killing Distances with the same Charge, when of equal Length in Inches; and the increased Quantity of Powder and Shot necessary to produce the same Effect in large-bored Barrels as in small, or what Proportion of Length will give them the same killing Distance with the same Charge.

No	Barrels Length in Feet and Inches.	Weight in Pounds.	Diameter of the Bore in Fifths of an Inch.	Length in Diameters.	Charge of Powder in Grains Weight.	Charge of Shot in Drams Weight.	Killing Distance in Yards.	Increase of Powder.	Increase of Shot.	Increase of killing Distance.
1	3 0	$4\frac{3}{4}$	$6\frac{10}{.}$	60	90	16	40			
2	3 6	$4\frac{3}{4}$	$6\frac{10}{.}$	70	90	16	46			
3	4 0	$4\frac{3}{4}$	$6\frac{10}{.}$	80	90	16	52			
4	3 0	$4\frac{3}{4}$	$7\frac{10}{.}$	$51\frac{10}{3}$	90	16	34	119	21	40
5	3 6	$4\frac{3}{4}$	$7\frac{10}{.}$	60	90	16	40	119	21	46
6	4 0	$4\frac{3}{4}$	$7\frac{10}{.}$	68	90	16	46	119	21	52
7	3 0	$4\frac{3}{4}$	$8\frac{10}{.}$	45	90	16	28	158	28	40
8	3 6	$4\frac{3}{4}$	$8\frac{10}{.}$	$52\frac{10}{4}$	90	16	34	158	28	46
9	4 0	$4\frac{3}{4}$	$8\frac{10}{.}$	60	90	16	40	158	28	52

Explanation of the TABLE.

In this table, N° 1 is a barrel I have had ten years practice with, both in the field and at fixed objects experimentally; and whoſe killing diſtance is well aſcertained; it is therefore given as the ſtandard barrel: its weight, as may be ſeen in the ſecond column, is four pounds three quarters; the ſtock and lock three pounds and a quarter, which together makes the whole gun eight pounds: a heavier weight than moſt gentlemen chooſe to carry, though I think no gun ſhould be lighter. Its killing diſtance will be found to be forty yards: ſo that a comparative view is given of that with two others of the ſame bore, but different lengths, ſhewing alſo how much encreaſe of ammunition is neceſſary to give barrels of a larger ſize the ſame killing diſtance: ſo that any perſon may judge what ſort of gun he chooſes to have made, or what the gun he ſhoots with is capable of doing, by gauging the bore, meaſuring its length, and weighing the whole gun, and then comparing it with the table, and adding or deducting according to the rules laid down. For inſtance, ſuppoſe any perſon has a gun, whoſe length is three feet three inches, the diameter of the bore ſix-tenths and half of an inch, which is thirteen-twentieths, its killing diſtance will be thirty-ſeven yards, by taking the medium between the firſt and fourth barrels in the table, if

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it had been of the ſame length; but as it is three inches longer, three times one yard muſt be added to thirty-ſeven, which makes forty yards*, the diſtance required: but it is neceſſary the weight of the gun ſhould be the ſame, in order to carry the ſame charge. If its weight is more or leſs, its killing diſtance will be proportionably greater or ſmaller, as its charge muſt be diminiſhed or increaſed accordingly.

N° 4, 5, 6 in the table, require five additional drams weight of ſhot, and 7, 8, 9, twelve drams, to give them the ſame killing diſtance as N° 1, 2, 3; of courſe ſome additional weight muſt be added to thoſe guns, or the re-action would be too ſeverely felt.

The proportion of powder I have allowed, may be thought by ſome to be inſufficient, but from great experience I think it is enough: for if the charge of powder is encreaſed, the quantity of ſhot muſt be decreaſed: and, as velocity is not ſo much wanted as the quantity of ſhot, I flatter myſelf the proportion will be found to anſwer. To lay down an exact rule is impoſſible, on account of the variation in the ſtrength of powder: the charge I ſpeak of is ſingle Battel, a compariſon of whoſe ſtrength with that of double Battel powder may be ſeen in the experiments on the proof of that article, which will ſerve as a guide

* In the above, fractions are avoided, as being uſeleſs in ſuch calculations.

in caſe the double ſhould be uſed. The effect of powder will alſo vary from the formation of the barrel with which it is uſed: if all barrels for fowling were cylindrical in their bores, this would not happen; but, as ſome are a little chambered or enlarged at or near the breech, and others at the mouth, ſome allowance muſt be made for variation: for example, a chambered barrel will always recoil more than another. One more remark I ſhall add, which is, that the velocity of a gun muſt be calculated from the diameters of the bore, not from its length in inches; for which reaſon ſmall-bored guns recoil rather more than large, of courſe require ſomewhat more weight in proportion to the charge; that is, if a barrel of ſix-tenths bore require a load of two ounces of ſhot, and ninety grains weight of powder, whoſe weight is four pounds three quarters, a barrel of eight-tenths bore, requiring three ounces and a half of ſhot, and an hundred and fifty-eight grains of powder, ought to be nearly four pounds heavier, according to the proportion of the different charges; but the difference of velocity in the ſmall bore requires its weight to exceed that proportion, ſo that the large-bored barrel thus loaded need not be quite four pounds heavier to make the re-action equal.

It is evident from what has been ſaid, that weighty guns have a conſiderable advantage; young ſportſmen therefore ſhould not be afraid of carrying ſuch as would give them the greateſt chances

chances of killing: and, though it is clear a large bore muſt have more charge and more weight than a ſmall one, to put the ſame number of ſhots into a ſmall mark; yet the ſpace that the ſhots cover at a given diſtance will be greater; of courſe a gun of a medium bore is well calculated for a middling ſhooter, if he can bear two or three pounds additional weight; above which ſize, I look upon all barrels as uſeleſs, and defective in the art of ſhooting flying. On the other hand, a good ſhot ſhould never ſhoot out of cover, but with a ſmall-bored gun of ſix-tenths of an inch, or perhaps of five tenths and an half, becauſe with leſs weight and length of barrel, and leſs charge, his gun will have the like effect, if truly pointed, with leſs fatigue and leſs expenditure of ammunition.

Having run through all the neceſſary remarks on gun barrels for the purpoſe of ſhooting flying, and pointed out rules for the diſcovery of their powers, by which perſons may order ſuch as they think will beſt ſuit their intention, I ſhall dwell no longer upon that part of a gun, but conclude this treatiſe with a few obſervations on the ſtock and lock, ſituation of the touch-hole, direction for taking aim at moving objects; with ſome remarks on making ſhot, proper wadding, &c.

STOCKING OF GUNS.

The ſtock of a gun ſhould be of ſuch proportional weight to the barrel, as to make it mount eaſy without being top-heavy, otherwiſe it will be apt to ſhoot under the mark, from the weight hanging too much on the left hand, which inſenſibly yields to the preſſure, particularly in quick ſhooting. No perſons ſhould uſe themſelves at firſt to ſhoot with ſtocks very much bent, as they have two diſadvantages; firſt, that they are more eaſily broken; and ſecondly, that they are more liable to throw up the fore part of the gun, and ſtrike the face in firing, and this upon the principle and for the ſame reaſon that all cannon do the ſame thing, by the wrong ſituation of their trunnions. See the remarks on carronades, pages 63—65.

If a ſtock was perfectly ſtraight, the whole re-action would be in a direct line backwards againſt the ſhoulder; becauſe the action of the powder when fired is in all parts of the barrel equal, as much downwards as upwards, and as much on one ſide as the other, conſequently in itſelf it has but one inclination; but when the barrel is fixed in a ſtock, whoſe declination is four inches at the extremity of the heel from the line of the bore, the butt muſt be conſidered as the arc of a circle, deſcribed from that part which is brought into contact with the ſhoulder, which

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we will ſuppoſe to be about two inches below the heel, and which will make the center of motion ſix inches from the line of action, it being a ſemi-diameter of a circle of twelve inches: from this it is evident, every gun, more or leſs, has a motion upwards when fired, by endeavouring to turn upon its axis. But to ſhew this more clearly, let us ſuppoſe A B, fig. 2, the centre line of the bore of a gun, and B C the angle of difference between the butt and the barrel; then deſcribe a circle from C, which we will ſuppoſe a wheel moveable upon its centre C; if then the barrel was fired at the extremity of the wheel B, it would unavoidably move upon its axis in the direction of the dotted line D; but if the barrel was fixed in a direct line with the axis of the wheel C, as ſhewn by the line E, it could have no motion either way. It is not poſſible to delineate the ſtock of a gun ſuitable to all perſons *, becauſe much depends on the make of a

* In peruſing a ſcrap of a publication, which I was favoured with by a friend, intitled, A Diſſertation on the Errors of Markſmen, by a Mr. Lemon, we are told with much propriety, that a perſon, for ſhooting flying, ſhould have his gun-ſtock fitted to him as exactly as he would the ſhoes he wears; there are ſome other obſervations in this work that merit attention, particularly the method of taking aim: but I cannot agree with him, that a perſon may be taught in half an hour, an art which few arrive at to perfection in twenty years, or during life, which he propoſed to do. The brothers of the trigger are however left to regret, with me, that no more than three or four numbers of this work have made their appearance.

perſon

perſon for whom it is intended; it ſhould, however, be as long as will admit of the trigger being reached with eaſe, becauſe the cloſer the gun is preſſed againſt the ſhoulder, without conſtraint, the leſs will be the recoil felt.

The laſt author mentioned is rather diffuſe on the ſubject of carrying a gun, and taking aim; and recommends ſuch an obedient attention to readineſs, as only becomes a man of his profeſſion *; and I hope no one will follow his precepts of carrying a gun always full cocked; for, beſides the reflection of the conſequences that might enſue, by the deſtruction of a dear friend, the companion of our ſports, I do aver it is uſeleſs, though too frequently practiſed amongſt the unthinking part of mankind, and particularly game-keepers, who think they cannot be ſufficiently ready without it: but coolneſs is the firſt neceſſary qualification of a good ſhot, which once attained, the mind becomes no longer agitated by the ſudden appearance of game on wing; and the ſame motion that lifts the gun to the ſhoulder cocks it. If a perſon is in expectation of game, the beſt and ſafeſt method of carrying a gun, is in a diagonal line acroſs the body, reſting the barrel on the left arm, with the fore-finger of the right hand upon the trigger, and the thumb upon the cock; in this poſition, the act of cock-

* Mr. Lemon ſtiles himſelf "that moſt able park and "game-keeper, and famous marksman."

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ing is inſtantaneous with the motion of lifting the gun to the ſhoulder.

In taking aim perhaps a few inſtructions may not be unacceptable, and may aſſiſt the inexpert ſhooter; but the misfortune is, few ſuch ſportſmen have coolneſs or ſteadineſs enough to take any aim at all. I have generally obſerved, bad ſhots ſeldom kill, except when a bird riſes at a conſiderable diſtance, when the chances of the divided ſhot are more in their favour than the accuracy of the aim they took: this alone ought to teach them that a certain diſtance is neceſſary to give them every probable ſucceſs; but hurry and confuſion ever prevents their killing at ſmall diſtances, from the inaccuracy of the aim, and the undivided ſtate of the ſhot, except by mere accident; and I believe every one will agree with me, to teach coolneſs and deliberacy is not to be done; but when once that is acquired, which can only be by practice and perſeverance, the following obſervations may be of uſe towards becoming an adept.

Before a ſportſman takes a gun into the field, if he expects to do execution with it, he ſhould repeatedly lift it to his ſhoulder, to ſee if the length and bend of the ſtock ſuits him, that is, if he can readily bring an object in a direct line of the barrel; for if that cannot be done with expertneſs, he cannot expect to reap much fruit from his toils. The appendage on the muzzle of a gun, called the ſight, is nominally of uſe only, and

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may ſometimes be of diſadvantage; for if it is more elevated than a line drawn from the breech is parallel with the bore, and the viſual line of direction is taken thereby, the body of the ſhot will infallibly be thrown below the object; and it is a difficult matter to regulate the elevation of a gun above the object, when flying in a direct line from one, becauſe the object in that caſe would be covered with the gun. The fact is, moſt perſons ſhoot below the mark, by the reaſon gravity is always acting upon the ſhot, and the body of ſhot will naturally be thrown below the mark at the diſtance of forty yards, although the line of the ſight is exactly parallel with the bore. If therefore a ſight is thought neceſſary to direct the eye at all, it ſhould be as little elevated as poſſible, in order that the actual line of the ſhot ſhould be rather above the viſual line of direction. There is another circumſtance to be conſidered in firing at a moving object, which is the continuation of the aim or motion of the gun with the object at the time of pulling the trigger, for it ſignifies little that the aim was exact before, unleſs the point is continued till the ſhot leaves the mouth of the piece; for it ſeldom happens that a bird flies in a direct line from one. If a bird is in any degree aſcending, it is obviouſly neceſſary to keep the muzzle of the gun as fully upon him as poſſible, by only ſeeing a portion of him above the gun, ſufficient to guide the direction. In croſs ſhots, or ſuch as paſs nearly at right angles,

or

or hip ſhots, or ſuch as move in a diagonal line from one, care muſt be taken to keep the muzzle of the gun rather before the head of the bird, and this muſt be meaſured by the angle of the bird's direction, and the velocity with which he flies.

The meaſuring the diſtance of an object with the eye is eſſentially neceſſary, in order to know, when a bird riſes near, what diſtance to allow him, ſo as to gain all advantages the gun is capable of giving: the misfortune is, we are too apt to judge of the diſtance by time, and not by the eye; for inſtance, when a bird riſes near, and makes a half circle round the ſhooter, he may have fled ſeventy or eighty yards before he has obtained a ſufficient diſtance to gain all the poſſible chances of ſucceſs: in this caſe it would be proper not to attempt to aim till the bird begins to move ſomewhat in a line from, or recedes farther from the markſman; for, as the practice of moſt ſportſmen is to ſhut one eye, and having been uſed to meaſure diſtances with both, it becomes more difficult to aſcertain it: for though we ſee clearly with one eye, yet we don't ſee ſo diſtinctly; and yet we ſee diſtinctly only with one eye, when both are open. This may appear a paradox, but which I will endeavour to explain, as the art of ſhooting, ſomewhat, in my opinion, depends on it; and, though I believe it is intirely a new thought, I will hazard the opinion. I have met with ſome few perſons who conſtantly ſhoot with both eyes open; I have alſo met with others who had but one eye; all of which

which ſhot well. Thoſe who have never tried their eyes, probably don't know that one is invariably ſtronger than the other; from what cauſe, it is difficult to aſcertain; but ſo it is. It is evident, however, the ſame object cannot be ſeen by both eyes in the ſame line, which may be proved by ſhutting one eye, and by holding up a finger intercept the viſionary rays of a diſtant object; then open the other eye, and the object will again be ſeen. In order then to try which eye is ſtrongeſt, and forms a direct line with the object, take the bowl or loop of a key, hold it at a diſtance from the body, and endeavour to command a diſtant object through it with both eyes; then, without motion of the hand or head, cloſe the left eye, and if the object is ſtill ſeen through the bowl of the key, ſhut that eye and open the left, and the object will be ſeen at a conſiderable diſtance to the left, and not in a line with the bowl of the key: this is a proof the right eye was ſtrongeſt. Now as it is evidently impoſſible that any perſon ſhould ſee an object equally diſtinct with both eyes at once, and that one eye is invariably ſtronger than the other, it becomes a matter of conſideration with a ſhooter, which of his eyes is the director; for, ſhould he cloſe the ſtrongeſt eye in the act of ſhooting, it might be a difficult matter to attain that art in perfection; and I would recommend him to practiſe with both eyes open, eſpecially as I have clearly ſhewn it is one eye only that draws the line of direction; but then it muſt be

conſidered whether he ſhoots right or left-handed; for if his left eye is ſtrongeſt, he cannot take a line of direction on the right ſide, becauſe the ſtrongeſt eye is not capable of being brought low enough with the line of the barrel, and of courſe would be liable to produce errors in ſhooting at moving objects. From this reaſoning it ſhould appear obvious, if the ſtrongeſt eye is on the ſide of the directed gun, no error could enſue from ſhooting with both eyes open, by the aid of a little practice; for, as I ſaid before, no perſon can meaſure diſtinct diſtances ſo well with one eye ſhut; it is evident therefore that material advantage would be gained: from the ſame reaſon, a perſon with one eye is capable of meaſuring diſtances from uſe, and diſcerning objects nearly as diſtinct as with two.

GUN LOCKS.

Much has been ſaid on this neceſſary part of a gun, in the ſubject of Muſkets, I ſhall therefore only add one or two obſervations.

For the purpoſe of ſhooting flying, there ſhould be as little impediment to the motion of all the works of a lock as poſſible, by leſſening as much of the friction as its nature will admit of: the beſt in uſe are moſt certainly thoſe termed in general off-ſet locks, that is, ſuch whoſe work is ſet off from the plate, except at a ſmall part near the centre of motion, by which means friction is conſiderably

conſiderably leſſened: however, in the junction of the main ſpring with the tumbler, in moſt locks, there is much friction: to obviate which there ſhould either be a ſmall roller in the extremity of the ſpring, where it bears againſt the tumbler, or a moveable link fixed in the arm of the tumbler, to be received into a notch of the main ſpring: this laſt I think preferable, as it gives the cock a more uniform motion. The feather ſpring, or that belonging to the ſteel, ſhould not be made without a roller.—For the reſt ſee my remarks on muſket locks.

It will be proper however here to ſay, that it is a miſtaken notion to have the cock made to fall with a very ſlight pull of the trigger; many a fair mark is miſſed thereby; for it ſometimes unavoidably happens, in traverſing the gun, the finger is preſſed a little more than uſual againſt the trigger, ſufficient to fire it before a point is obtained; indeed I have frequently known guns go off from that cauſe in bringing them to the ſhoulder. The pull of the trigger, therefore, ſhould not be too eaſy, but in a medium, and that pull ſhould be as ſhort as poſſible; that is, there ſhould be no perceptible motion of the trigger, till the cock falls; when there is, it is called a long pull, and deceives the ſhooter: to remedy that defect, the trigger ſhould have no motion to and fro upon its pivot when full cocked; and the arm of the trigger, and that of the ſear, ſhould be ſufficiently

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ſtiff not to yield to the applied force of the finger, without forcing down the cock.

TOUCH-HOLE.

IN my experiments with mortars, it was clearly proved the ſituation of the touch-hole ſhould be as near the breech as circumſtances will admit of: in cannon, it is neceſſary to leave ſome ſpace between it and the breech, leſt by the lodgment of the bottoms of cartridges, a communication of fire might be cut off. In portable fire-arms, whoſe length in diameters are conſiderable, ſuch as muſkets and fowling pieces, Mr. Thompſon ſeems to have proved the ſituation of the vent is not of much conſequence *.

I would however have the touch-hole placed in them within the fourth part of an inch of the breech, or, as Mr. Thompſon very judiciouſly recommends, that the bottom of the bore ſhould be hemiſpheric, and the vent to be placed perpendicular to the centre that deſcribes the arc of the chamber; and not as they are often placed, below the ſurface of the breech, a groove being cut in that to receive it: nor would I have it abſolutely cloſe to the breech, becauſe it frequently happens, by the accumulation of matter from the fired powder, that the vent is choaked,

* Phil. Tranſ. vol. lxxi. part ii.

or from the falling of ſome ſcale to the bottom, when the gun is put into a poſition to be reloaded; which is often the caſe, as may be ſeen by turning a gun after firing ſeveral times: in either of theſe caſes, it is impoſſible it ſhould fire quick, and frequently is the cauſe of flaſhing in the pan. If, however, the touch-hole of a gun is not in the ſituation deſcribed, it ſhould be primed laſt, and have introduced the point of the ſhaft of a feather, after ſtripping off the fibrous parts, or a bit of wire; when it is taken out after loading, there is a certainty of a free paſſage for the prime communicating the fire to the charge. There is another circumſtance neceſſary to the ready firing of a gun, which is the diſtance the touch-hole is placed from the pan: in the firſt place, a pan ſhould be ſhallow and broad, the former, becauſe a conſiderable depth of powder, if the touch-hole is low, will prevent a ready communication of inflammation, as I have always experienced: and the latter is proper to receive with more certainty as many ſparks as poſſible: the touch-hole ſhould therefore be made as near the ſurface of the powder in the pan as the ſhutting of the ſteel or hammer will admit of without interfering with it, and this is of more conſequence in firing at moving objects than is perhaps in general thought to be. My experiments on the ſituation of touch-holes, page 41, &c. as well as Mr. Thompſon's in the Philoſophical Tranſactions, compleatly refute the vulgar error, that

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the further it is placed from the breech, the greater the recoil.

Gold touch-holes are much in favour with gunſmiths, becauſe they produce them a greater profit than any other; and ſportſmen are too apt to be guided by their recommendations: it is true, it does not corrode by the nitrous acid; but this is not a conſideration, when we know that a common touch-hole is ſufficiently durable under the ſame circumſtances: what is moſtly wanted, is a hard ſubſtance, which is proof againſt the violent action of the fire, and the force of the rarefied air preſſing through it at the moment of exploſion; for this reaſon, gold will not be equally durable in every ſort of barrel; for by its ſoftneſs and ready fuſibility, ſome barrels will blow away part of the touch-hole in a very ſhort time, and the pan will be frequently gilt in the direction of the fire from the vent, and appear as if a bit of gold had been rubbed againſt it. I would therefore recommend a ſimple touch-hole drilled in every new barrel, which is more durable than that of gold, if it is found to blow at the vent; and in all caſes will be ſufficiently laſting, with proper care in cleaning, and oiling after uſe: if theſe by hard ſervice wear and become too large, or are found to blow partially, they ſhould be buſhed or bouched with ſteel, and if hardened afterwards, will be ſtill more laſting: but for this purpoſe, it is requiſite the breech of the barrel ſhould be put into the fire, as the ſteel muſt be drilled when

ſoft, and after heating plunged into water to harden it, and even this extreme hardneſs is not proof againſt the action of fired powder in ſome thin barrels, but exceeds all others in durability. I have now a gun by me, which rendered a gold touch-hole uſeleſs in two or three hundred fires, and has now blown an angle in one of the hardeſt ſteel.

Thoſe who object to heating their barrel, muſt be contented with ſoftened ſteel, which indeed will be found ſufficiently durable for general uſe. Though it is certain a new touch-hole might be drilled, and hardened before it is ſcrewed into the barrel, by an expert workman.

SHOT.

THERE is nothing, perhaps, ſo material in the art of ſhooting, as the choice of this article; and to render a work of this kind as compleat as its limits will admit of, every thing ſhould be mentioned that can give the ſhooter any advantage.

Patent ſhot has, deſervedly, a pre-eminence; for by their perfect orbicular form, their paſſage through the air is leſs obſtructed, of courſe their velocity leſs impeded. In common ſhot it frequently happens, in a charge, there are ſeveral grains ſo exceedingly defective, as to be intirely

uſeleſs, and ſerve only as an addition to re-action: the patent has therefore the preference, but does not poſſeſs ſo material an advantage as is generally ſuppoſed; and it is at diſtant objects, or what is called long ſhots, that the advantage is derived; but if we ſay one bird more in thirty is killed by it, perhaps it is the utmoſt. The cauſe of much diſappointment with my brothers of the trigger, originates from a miſtaken notion, that more birds are to be killed at conſiderable diſtances with large, than with ſmall ſhot, which is an error of the utmoſt conſequence to the ſportſman. I have frequently, amongſt my acquaintance, found thoſe who uſed a ſmall proportion of ſhot to the powder, and becauſe they wounded two or three birds, without bringing them to the ground, were at a loſs to account for it, but by the inferior ſize of the ſhot; whereas, had their ſhot been one ſize ſmaller, an additional grain might have taken a wing or a vital part, and have inſured the object: the range of large ſhot, it is true, is greater than ſmall; but then it flies ſo thin, that is, in ſo divided a ſtate, that ſingle birds are never to be killed with certainty at ſo great a diſtance as with ſmall; it is the quantity, and not the quality, that does moſt execution; and I again repeat, that velocity is not the object of a ſportſman; for we know that ſmall ſhot will ſometimes, by accident, kill at ſeventy or eighty yards, which is forty yards more, probably, than the gun's certain killing diſtance, and which proves that it has ſufficient

velocity at that diſtance to do execution, if it takes a vital part. The ſize of ſhot muſt ſomewhat be regulated by the object of perſuit; for if one bird preſents a ſurface as large again as another, a ſhot whoſe ſize gives in a charge half the number of grains may be uſed with a proportional advantage: but as there is no neceſſity of uſing ſo large a ſhot for large birds, when ſmaller has ſufficient velocity to kill; and as the vital parts of ſuch bear an equal proportion, their killing diſtance is greater than in ſmall birds, with a ſhot whoſe charge produces only one-third, or one-fourth leſs in number. For partridge or grous, in the beginning of the ſeaſon, N° 1, and, perhaps, for the former, it ought never to exceed that ſize. For heath fowl or pheaſant, N° 2, in the beginning, and ſeldom, if ever, N° 3 *, except with guns of more than common length; and I look on the numbers 4, 5, and 6, as uſeleſs, except for flocks of geeſe, or other large wild-fowl. The following table will ſhew the number of grains of ſhot in an ounce of Watts's patent, and alſo that of the common ſort made at Briſtol, by which any perſon may aſcertain the ſize required of the London ſhot, or any other place where it is numbered in a reverſe manner, by only weighing a given quantity, and telling the number.

* Unleſs it is N° 3 patent, which by the table will be ſeen to contain, in a charge of two ounces, only 16 grains leſs than N° 2 of the common ſort.

TABLE

TABLE OF SHOT.

N°.	Watts's patent, one ounce.	Com. ſhot, one ounce.	Watts's patent, two ounces.	Com. ſhot, two ounces.
+	320	312	640	624
1	224	212	448	424
2	188	156	376	312
3	148	112	296	224
4	104	86	208	172

Whoever will take the trouble of counting the number of ſhot of different ſizes there are in a charge, will at once perceive how much more probable it is to ſtrike the vital parts of a bird with ſmall, than with large ſhot, from the ſuperior quantity of grains; for though large ſhot may have ſomewhat more velocity, yet it is thrown ſo exceedingly divided at forty yards, that only one grain will probably take place, and may not be ſufficient to bring down the object, unleſs it ſtrikes a vital part: and I queſtion much whether large birds, whoſe feathers are of a looſe texture, ſuch as game in general, would not be more frequently killed with N° 2, at all ſeaſons, than with any of a ſuperior ſize.

For ſnipes, croſs ſhot, marked thus +, which is ſmaller than N° 1, is the beſt, and is by no means improper for woodcocks, as they are eaſy

to kill. Beſides the numbers ſpecified in the table, there are of common ſhot, four other ſizes, viz. two larger than N° 4, namely 5 and 6, the other two ſmaller than + ſhot; and what is extraordinary, are denominated 7 and 8 *; but as none of them are of uſe to the flying markſman, it would be abſurd to crowd a work with uſeleſs matter. N° 7 indeed might be advantageous to ſuch who divert themſelves at ſhooting ſwallows, or other diminutive ſpecies of birds. Notwithſtanding what has been ſaid on this ſubject, I make no doubt there are ſome good ſportſmen who differ with me in opinion concerning the ſize of ſhot; but there are fifty to one of inexpert ſhooters, and which is really the cauſe of more diſappointment in their purſuits, than they would otherwiſe experience.

A perſon who ſhoots tolerable well, at moderate diſtances, with a middling-ſized ſhot, is probably contented with his ſucceſs, without riſking experiments in the field; but that is no reaſon he ſhould not ſhoot better with that of a ſmaller ſize: few people have perſeverance ſufficient to undergo the pains and labour I have done to aſcertain all the advantages to be derived from the choice of ſhot, and a judicious method of loading. For this laſt, ſee the article Wadding.

The Briſtol patent ſhot, invented by Watts, and ſtill bearing his name, is made in a very different

* By ſome called Sanby and Muſtard ſhot, properly N° 7 and 8 of the London manufactory.

manner

manner from the patent milled ſhot. The latter is ſaid to be made by cutting ſheet lead, by a peculiar inſtrument, into cubical ſhapes, after which, it is put into a hollow iron cylinder, which is ſo fixed as to turn upon its axis in a horizontal poſition, by which means the continual friction of the dice againſt each other, and againſt the ſides of the cylinder, renders them perfectly ſpherical: by this method common ſhot might be rendered more orbicular, as bullets are for the uſe of the army. The Briſtol patent ſhot is made exactly in the ſame manner as the common ſort, except that the metal is ſufficiently cool before it comes into contact with the water, by reaſon of the diſtance it has to fall into the water trough, placed beneath to catch it.

In the ſimple method of making ſhot, the cullender, through which it paſſes in a melted ſtate, is placed within four or five feet of the water, to receive and condenſe the fluid globules of lead; and, not being at a ſufficient diſtance to admit of its conſolidating before it touches the water, each grain, which otherwiſe would have been perfectly round, receives a compreſſion on that part which firſt comes in contact with the water, and generally forms a ſlight concavity; and this invariably in every grain, more or leſs, according to the heat of the metal.

This, in the patent ſhot, is obviated by the diſtance it has to fall, by which means it is conſolidated before it touches the ſurface of the water:

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the height is regulated by the ſize of the ſhot: the largeſt, I believe, is found to cool ſufficiently in the time it is deſcending about 140 feet: the ſmaller ſizes in a much leſs diſtance. Which of the two patent ſhots have a claim to pre-eminence, is difficult to determine, unleſs they were paſſed through the ſame ſieve, and their ſpecific gravity accurately aſcertained. Before I leave this ſubject, I ſhall make one more remark on the errors of ſportſmen, in regard to their choice of ſhot. It is no uncommon thing to ſee a ſhooter ſtrike a conſiderable quantity of feathers out of a bird, which he declares is wounded and muſt die, and avers, if his ſhot had been larger, he ſhould have brought it down; with this notion he takes the field the next day, prepared with heavier ſhot, and expects to be ſucceſsful, but in this he is ſure to be diſappointed; for, perhaps, the occaſion of his only feathering a bird before was, becauſe the ſhot was too large, and one grain had only grazed the bird, without drawing blood; for if a ſhot ſtrikes a bird full, and enters the fleſh, the feathers are carried in with it, and ſeldom any ſeen floating in the air; on the contrary, a ſhot paſſing cloſe to the ſkin of a bird without entering, the feathers are ſtript from that part; and from the profuſion of feathers left behind, it is declared to be hard ſtruck: the harder, therefore, a bird is hit at long ſhots, where only one or two grains have taken place, the leſs viſible ſigns of it are obſerved, unleſs the bird drops the legs, or inſtantly towers;

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for which reaſon the bird ſhould be cloſely followed with the eye as far as it can be ſeen; for it frequently happens that a bird falls dead at the diſtance of four or five hundred yards or more, and is as frequently loſt for want of proper attention to the flight after firing. It is no uncommon thing to ſee a bird drop its legs at the inſtant of firing, and fly off in an undulated motion, or tower to a great height: all theſe are certain ſigns of death, and are generally occaſioned by a contuſion on the vertebræ; for if the ſpine is injured, paralyſis enſues. If the brain is contuſed, the bird mounts, but the legs are not pendent.

WADDING.

VARIOUS are the opinions concerning the proper material for this purpoſe: let us, therefore, firſt enquire the uſe and intention of it; I mean of that between the powder and ſhot, for as to the other, it is of no more conſequence than to prevent the ſhot from running out of the barrel, or getting looſe, and ſeparating at a diſtance from the powder; whereas that next to the powder is to anſwer two ends; firſt, to prevent the ſhot mixing with it, and ſecondly, to prevent the elaſtic fluid from paſſing and loſing any of its force, through the interſtices of the ſhot. If we employ a weighty body, it adds to the recoil, and

deducts

deducts from the force of the ſhot: and if we uſe an incompact ſubſtance, it yields to the preſſure of the elaſtic fluid, and weakens its action: what is therefore wanted, is a light, thin, compact body, ſuch as will lie cloſe to the ſides of the bore, occupy very little ſpace, and add nothing perceptible to re-action. By ſome perſons much confidence has been placed in card, by others pieces of hat, or leather, cut to fit the bore exactly by an inſtrument for that purpoſe; but for theſe the cap of the ram-rod muſt be made nearly as large as the bore, in order to force them down even; and become difficult to ram down, when the gun is ſomewhat foul, beſides occaſioning delay when expedition is required. Tow and pieces of woollen cloth have alſo been uſed; but I have never found any thing ſo proper as a double piece of thin ſoft paper; this ſhould be rammed down with ſome force upon the powder, and a ſtiffer paper upon the ſhot, in like manner; for the cloſer the charge is connected together, the greater will be the force: remembering that more preſſure is required to large-grained powder, and large ſhot, than to ſmall.—There is ſtill a method of loading that requires no ſeparate wadding, and is, in my opinion, the beſt, eſpecially for double barrels: many a diſappointment have I experienced in ſhooting with ſuch a gun, for by the ſhock of the firſt-fired barrel, the ſhot has become looſe in the other, and thereby loſt the greater part of its force; for if the gun is pointed nearly

parallel

parallel with the horizon, the ſhot has ſpread itſelf along the lower ſide of the bore, leaving the upper ſide vacant, by which the elaſtic fluid paſſes without exerting its whole force upon the ſhot; and thereby renders it impoſſible to kill at a diſtance, as the force exerted will be in proportion to the diſtance the ſhot is extended along the barrel. If the ſecond barrel was never fired immediately after the other, the charge might, and ought to be re-rammed; but as the utility of this piece is to take a ſecond ſhot immediately, where opportunity offers, it ſhould be guarded againſt; and, as I know by experience, ſix or ſeven folds of paper are not ſufficient to keep the ſhot compact, I have had recourſe to an expedient that not only anſwers that purpoſe, but throws the ſhot with more velocity, and leſs diverging.—I mean a cartridge; which is made on a mould or former, ſo as to ſlide eaſily down the barrel: this cartridge is to be filled with the charge of ſhot only, ſo that there needs no wadding upon the powder; for, as the cartridge is rammed down ſtrongly, with three or four jerks of the ram-rod, the paper gives on every ſide, and compleatly fills the bore, by which means none of the elaſtic fluid can make its eſcape, and the ſhot becomes ſo thoroughly fixed, that no ſhock from firing the other barrel can looſen it. The mould ſhould be made like that uſed for forming rockets; being compoſed of two pieces, one double the length of the cartridge required,

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the other about two inches long; into the end of the ſhort piece, a bit of wire is driven, as near the centre as poſſible, leaving about an inch without, which is to be made to fit into a hole at one end of the other piece; when theſe are put together, the paper is to be rolled on, the ſmall piece is then to be withdrawn about an eighth of an inch, ſo that a piece of packthread may be drawn tight round the cartridge between the junction of the two pieces, ſo as to cloſe the paper to the wire, the ſhort piece is then taken out, and a bit of thread tied round it, to keep the end tight: this is the bottom of the cartridge: it now remains only to be filled with the charge of ſhot, and tied cloſe to the ſhot at the other end, and the waſte paper cut off about a quarter of an inch from the thread, and the end doubled back over the thread. The paper for this purpoſe ſhould be thin and ſtrong, ſuch as is uſed for muſket cartridges; the ſize ſhould be ſuch as to go three times round the former at the bottom, and twice at the other end in the length of the cartridge: for this purpoſe, one ſide of the paper muſt be cut ſomewhat in a diagonal line, thus  . The reaſon of the ſuperior velocity of ſhot cartridges is the compactneſs with which ſhot are kept together when well-rammed down; and the ſhot will diverge rather leſs, becauſe the whole charge lies rather nearer the centre line of the bore. Beſides theſe advantages, there is another, which is the expedition in loading. It may be aſked, why the powder might not be uſed

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in the ſame manner, as a cartridge could be made with a diviſion; which would ſtill facilitate the loading? but the reaſon is obvious, for, as the powder muſt firſt be ſhook into the barrel, there would be a uſeleſs quantity of paper, which would add to the recoil; beſides the powder being more liable to attract damp, than when carried in a powder flaſk.

PISTOLS.

DUELLING is certainly a matter of great concern in this enlightened age, and in every civiliſed country, and ought moſt ſeriouſly to be taken up by the legiſlature, in order at leaſt to regulate ſuch a ſyſtem by law, as may be conducive to the general good, and to prevent ſo many brutal, inhuman, and predetermined murders, as ſtain the annals of this country. If it were poſſible to ſuppreſs the arm of man againſt man, where the intentions are apparently ſanguinary, without infringing on the bounds, or ſubverting the order of ſociety, it would be a wiſe and politic ſcheme, and equally worthy the attention of a miniſter, as of every good citizen, and the humane in general: but it requires a ſerious conſideration; the totally annihilating the laws of honour, would eventually remove that bar between men, which, I am ſorry to ſay, appears to be the etiquette of polite, civil, and peaceful ſociety,

ſociety, and might be conducive to a more dangerous violation of the laws of God: for if duelling was indiſcriminately heavily puniſhed by law, either by fine, impriſonment, or otherwiſe, or the death of an opponent atonable only by the life of the ſurvivor in action, it might draw upon a country calamities of a more dreadful nature—ſecret aſſaſſination; and reduce us to that ſtate of barbarity which the hiſtory of England is ſo replete with ſome centuries back. Many other reaſons might be aſſigned, why the laws of honour cannot be entirely done away: and in this the more enlightened part of the female ſex are particularly concerned; modeſty would be too frequently indecently attacked, and virtue ſtained by illiberality; and this alone is a ſufficient cauſe for the laws of honour. But I am by no means an advocate for duelling unconſtrained; certain reſtrictions are abſolutely neceſſary to ſociety.

What a degradation it is of the human faculties, for men to attempt the lives of each other for the mere matter of opinion in common converſation; becauſe the impreſſion of an object may vary from the light and ſhade, according to the ſituation they individually view it in! Inebriety too frequently terminates in a quarrel, and honour is put to the teſt, when the intellectual faculties are ſuſpended, or degenerated into idiotiſm or fanaticiſm. Exceſs of drinking is by no means an excuſe for illiberal language, or manual exertions; for although a man is no longer a rea-

ſonable

ſonable being, he himſelf has ſubverted the order of nature, and from the higheſt rank of the animal creation, he criminally ſinks into the loweſt, far inferior to the brute, whoſe never-failing inſtinct is a ſufficient and admirably implanted guide to all its neceſſities, ſimple and compound. If a perſon therefore ſhould unfortunately be deprived of reaſon by ſuch means, if he has intervals of ſenſe, he ſhould ſubmit his conduct to the inveſtigation of thoſe preſent who were ſober; if he is accuſed of improper behaviour, and aſks public as well as individual pardon for the inſult offered to amicable ſociety, ſuch conduct would conduce more to his honour than ten duels. It is a miſtaken notion of honour that has brought thouſands to the field: there are indeed many well-diſpoſed peaceful members of ſociety, who fall into ſnares unavoidably, from the petulance or brutality of others, and become victims to miſtaken honour, for want of preſcribed bounds, by means of which they might extricate themſelves with credit.

There are others forced to revenge from a breach of friendſhip and hoſpitality, by undermining a man's peace of mind, his worldly happineſs in various ways; of this deſcription there are many, and of that nature, which call for revenge, againſt the dictates of religion: and, tho' it muſt be admitted that a courſe of law is preferable in the eyes of God, yet the expence, and, I am ſorry to ſay, the uncertainty of juſtice, is

 frequently

frequently a bar to ſuch judicial inquiry; and it is not to be wondered, that in a mind deranged, reaſon ſhould vaniſh, and the animal powers be called forth to reſcue inſulted honour.

But it ſhould be recollected, a man's honour is not always recalled by killing his antagoniſt, or being himſelf wounded; for, as perſons in ſome caſes ſee with different eyes, and conſtrue words into different meanings, would it not be better to take the ſenſe of friends, who ſhould act as a court of enquiry, and decide on the fact? This honourable method would prevent many a duel; or be more juſtifiable (if I may uſe the expreſſion) to the challenger, in caſe the challenged cannot or will not make ample ſatisfaction.

The gentlemen of the army are in a ſingular and critical ſituation, they muſt neither fight nor let it alone: they are liable to be broke for ſending or receiving a challenge, at the ſame time incur a laſting diſgrace for declining it. I will not pretend to preſcribe rules for perſons of this deſcription, or to mark the boundaries or limits of their neceſſary reſtrictions, leſt it might interfere with military diſcipline; though in fact there can or ought to be only one opinion on that head. A commanding, or even a ſuperior officer, certainly loſes no honour by refuſing a challenge, if founded on diſcipline; and, as enmity may be brought forth and foſtered by command, which may afterwards be brought to maturity by ſome accident,

accident, on a trivial occaſion, much care and circumſpection is neceſſary in delineating the bounds of honour. If men have any ſenſibility, they muſt feel their awful ſituation, when honour, real or fictitious, calls them to the field of battle, in mutual attack and defence; they are attempting or perhaps actually taking away the life of each other, contrary to the laws of God: horrid reflection for either party! and doubly horrid for him who ſtains his hands with the blood of injured innocence!

> What hands are here! Hah! they pluck out mine eyes.
> Will all great *Neptune*'s Ocean waſh this blood
> Clean from my hand? MACBETH.

I would not ſhed the blood of the man I had injured for the univerſe. Let the ſenſitive reader ſtop here a moment, and take a retroſpect of the calamities that muſt enſue, and I am ſure he will aſk with me, Is there ſuch a monſter in the world? God forbid that ſuch a ſavage ſhould exiſt, who is capable of materially injuring any perſon, and then meet him with an intent of putting an end to his exiſtence!—If it is neceſſary, for the good order of ſociety, that men ſhould be anſwerable to each other for their conduct, ſurely ſome regulations ſhould be pointed out for ſuch unhappy individuals, who mutually meet, or are forced to the field of battle to decide what is too generally, and too miſtakenly, termed a point

of honour. The firſt buſineſs is, to prevent a haſty deciſion, by the ſword or piſtol, of a diſpute which may proceed from paſſion or inebriety, and to ſuffer the diſputants to cool, and reflect on the matter in queſtion*: if the injured then calls upon the injurer for ſatisfaction, and it is the decided opinion of the company who were preſent, that an apology is neceſſary, that ſatisfaction ought to be made in public before as many of the members of that ſociety as can be collected together; but if the injured is mentally diſtreſſed, and his peace of mind is deſtroyed, and thinks nothing can atone for the injury ſuſtained, but an appeal to the piſtol, the injurer muſt appear armed in the field according to the rules of honour; but he ſhould recollect, he is not come there to heap crime upon crime, by murdering the man he has injured: he is on all accounts to decline every chance or ſolicitation of firing firſt, and is to receive his opponent's fire in ſuch a defenſive poſition as his arms or his piſtol can be uſed in, ſo as to render his vitals moſt ſecure. If he fortunately eſcapes his opponent's ſhot, he ſhould then diſcharge his piſtol in the air; but if his antagoniſt is not ſatisfied with the reſult, and his intentions are ſtill bloody, he has then a right to act upon the offenſive as well as defenſive; for, having

* This would prevent many rencounters, and materially curtail the liſt of duels; but death in this caſe is deemed murder in law, being done deliberately and with ſuppoſed malice. Vide *Blackſtone's Comment.* vol. iv. p. 199.

given

given him the chance of his life, and made a previous ſubmiſſion, he is no longer bound by honour, juſtice, or humanity, not to prevent aſſaſſination. It is requiſite however to obſerve, that in all caſes of deciding honour by the piſtol, ſeconds ſhould be choſen, for many reaſons too obvious to detail, and whoſe buſineſs it is to interfere, after the circumſtances above recited. It often happens that we hear of a caſe or more of piſtols being fired by each party at a meeting; it may therefore be preſumed they have neither ſolicited the opinion of their friends, nor does the conſcience of either dictate to them, they are in the wrong; in this caſe, each ſtands upon ſelf-defence.

When perſons of this deſcription meet upon an affair of honour, the piſtols ſhould be loaded by the ſeconds, but in the preſence of the duelliſts, if required; and each hath a right to demand one piſtol of the other, in exchange for one of his, if he ſuppoſes they have any advantage, either from the length or ſize of bore; becauſe in each caſe there may be a material advantage, and without which they would not meet upon equal terms. After this neceſſary preliminary has taken place, the ground ſhould be marked out, and each take his ſtand at the diſtance of twelve paces or yards aſunder. It is then to be determined in what manner to proceed, whether by drawing lots for the firſt fire by the ſeconds, or by ſignal to fire together: if the latter (which is certainly the faireſt method) the duelliſts ſhould ſtand back to back, at the diſtance

appointed,

appointed, with their eyes directed towards the ſeconds (who ſhould ſtand at an angle equidiſtant from each) from whom the ſignal is to be taken: in this ſituation, they ſhould put themſelves in an attitude of making a quarter turn upon their centre; that is, turning to the right upon their heels, which is the readieſt mode of coming to the poſition of attack, preſenting the right ſide of the body, not the full front.

If the former plan is adopted, the perſon who is to receive the firſt fire, ſhould take care to preſent as ſmall a ſurface as poſſible, and to guard his vitals in the beſt manner with his piſtol and arms: his legs ſhould be cloſed, covering the left by the right leg, preſenting the ſide of his body, holding his piſtol with the lock outwards, as high as the head, to defend that part, by which means the elbow is formed into an acute angle, and the arm ſecures a large portion of the breaſt and neck: the left hand and arm is to be thrown round the right ſide, under the right elbow; in this poſition, he is to wait his antagoniſt's fire. In preſenting there is to be no encroachment of ground, by putting forward the right foot, unleſs by mutual conſent, as it would make nearly a yard difference in diſtance; but the left foot may be placed backwards to any diſtance, for the convenience of a ſtable footing, and ſteadying the body. The piſtol hand may be extended or contracted as convenience may require, in the act of firing; but the left hand or arm is not to be

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uſed to reſt the piſtol on, in order to ſteady the aim.—Here I ſhall leave this part of the ſubject, as it is not my intention to point out the beſt method of killing a fellow-creature, but to prevent death, if poſſible, by the beſt and ſecureſt poſitions of defence.

Too frequently are we ſhocked by the accounts of perſons fighting repeatedly on the ſame ſubject: others acroſs a table; or holding the oppoſite corners of a handkerchief, or the like. Such conduct is highly criminal; a human ſacrifice, in this unjuſtifiable mode of determining what are improperly termed affairs of honour, ſhould be deemed wilful murder by law.—Thus much I have written as the outlines of duelling, at the requeſt of a particular friend: may it ſtimulate ſome abler pen to be more diffuſe on the ſubject, is the author's moſt ſincere wiſh;—who will conclude with deſcribing the make of piſtols requiſite for perſons who are unfortunately called to the field of honour.

A duelling piſtol ſhould be at leaſt five-tenths of an inch in the bore, or five-tenths and a half, and at moſt ſix-tenths: in length of barrel, ſixteen diameters from the vent; which would be reſpectively in inches, eight; eight eight-tenths, and nine ſix-tenths. The weight of the ball, for the ſmalleſt bore, is three drams and a half, or about thirty-five to the pound: the weight of the largeſt, five drams, or twenty-ſix to the pound nearly: their diameters, that of the diameter of the bore,

or very near it, ſo that in loading the ball is forced down with a ſteel ram-rod; and no covering to the ball is required, nor any wadding uſed upon the ball. The weight of powder, one-ſixth the weight of the ball, or even a ſeventh, if of the beſt quality, is ſufficient.

The bore of the piſtol ſhould be of a perfect cylinder, or rather ſmaller at the mouth, in order that the ball, which at firſt is introduced with difficulty, ſhould afterward paſs with more eaſe. The bore to be well poliſhed, and the bottom or inſide of the breech plug to be hemiſpheric, as deſcribed in gun barrels; as well as the ſituation of the touch-hole. To the end of one of the ram-rods, a cup or thimble ſhould be made to ſcrew on, ſufficiently capacious to hold the charge of powder: in loading, the piſtol is to be inverted, and the powder introduced by the ramrod, till the cup touches the breech, or bottom of the bore, the piſtol is then to be turned up, and the ram-rod withdrawn, leaving the powder at the bottom, without any adhering to the ſides; a ſmall bit of ſoft paper is then to be rammed gently upon it, and the ball forced down till in contact with the wadding.

FINIS.